The Surgery of the Oesophagus.

AUTHOR(S):

Ohsawa, T

食　道　外　科

京都帝國大學醫學部外科學教室（鳥潟教授・磯部教授）
助教授　醫學博士　大　澤　達

The Surgery of the Oesophagus.

By

T. Ohsawa, M. D.,

Assistant Professor of Surgery,
(From the Surgical Clinics of Prof. **R. Torikata** and Prof. **K. Isobe**,
Kyoto Imperial University.)

Introductory.

In surgical operations upon the oesophagus, and even on its thoracic part, an apparatus for differential pressure is not only unnecessary but actually a hindrance. Today, when this fact has become well recognized, at least in our country, the surgery of the oesophagus may be said to have finally made a correct start.

Ever since Prof. R. Torikata, chief of the first surgical clinic, proposed "Free Thoracotomy" or thoracotomy without the use of differential pressure for this branch of surgery, at the annual congress of Japan Surgical Society in 1925, we have continued to make clinical and experimental studies from this point of view. As it is obviously impossible, however, to solve at once the many problems that confront us in dealing with this subject, we have made it our task first to develop the fundamental principles underlying the surgery of the entire oesophagus and secondly to establish the technical procedures of treating the lower segments of the viscus and the cardia.

In the following pages we shall present briefly the results of the experimental and clinical investigations that we have conducted along these lines.

Section I. The Fundamental Experiments on the Surgery of the Oesophagus.

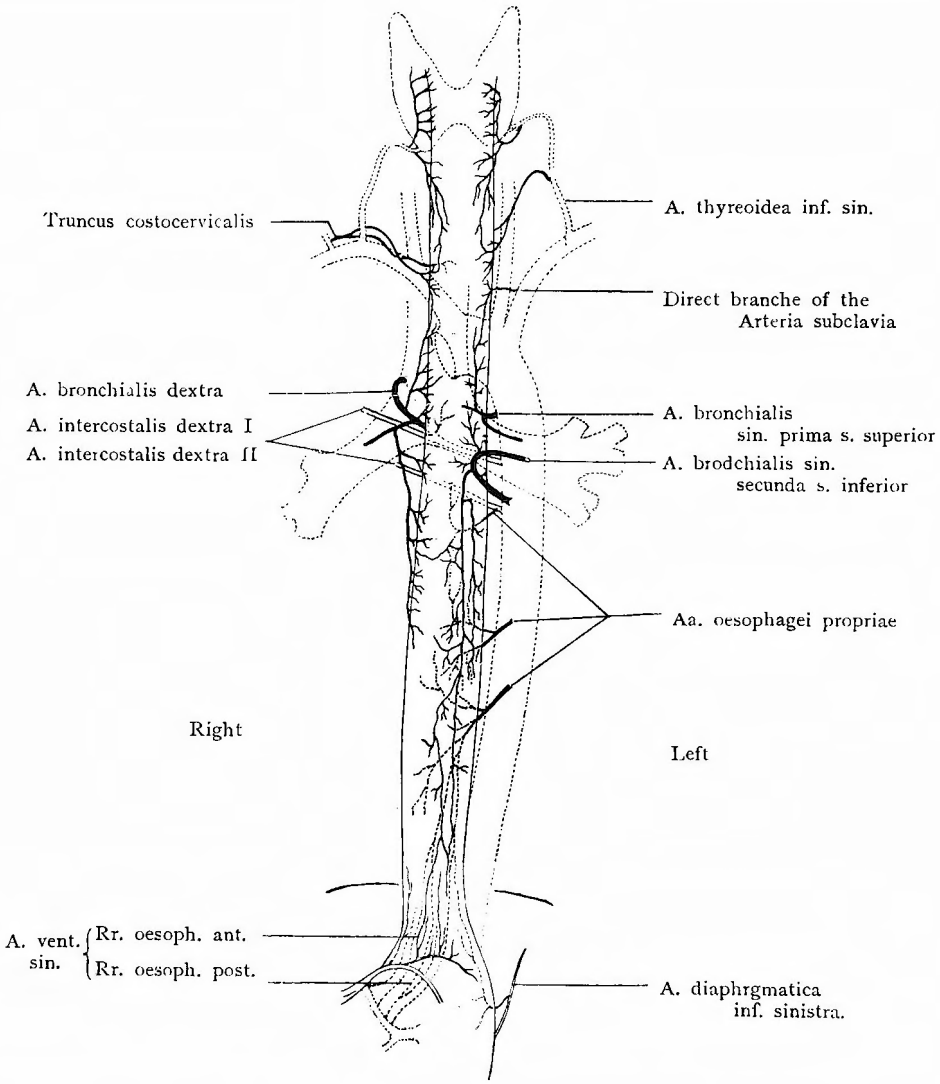
Chapter I. Experimental Observations on the Surgical Anatomy and Physiology of the Oesophagus.

1. *The Nutrition of the Oesophagus.*

Nutritional conditions of the oesophagus constitute the basic factor in its surgery. We have first reinvestigated thoroughly the arterial supply of the oesphagus on fifteen cadavera and found a few new facts which will be reported elsewhere (Fig. 1). Our next step was a quantitatve estimation of the blood volume distributed to its various segments. For this purpose, we have injected a quantity of one percent aqueous solu-

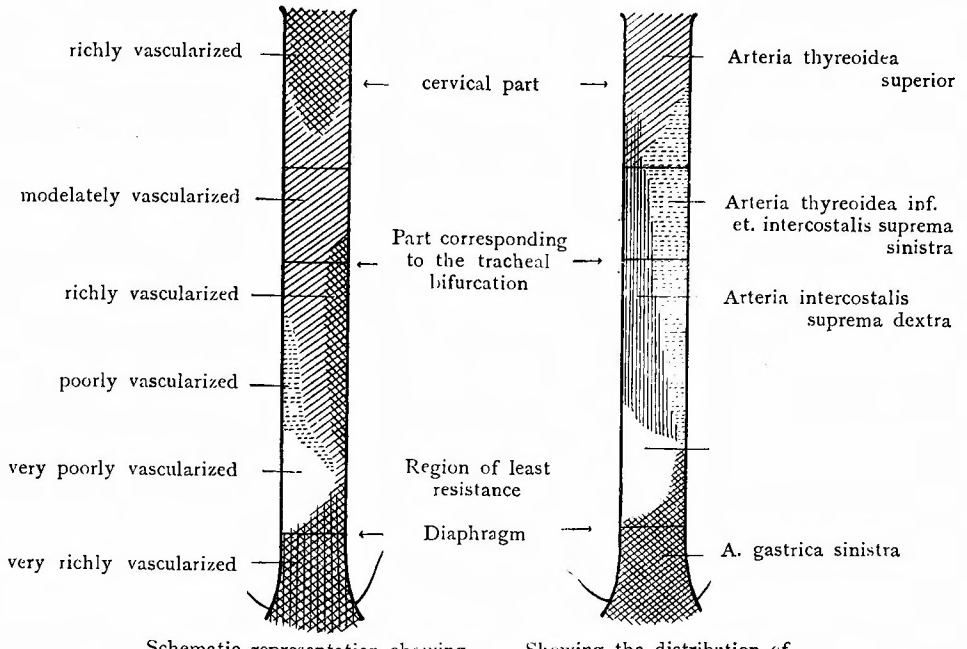
tion of mercury bichloride into the aorta of fresh cadavers or experimental animals; the different segments of the oesophagus were then subjected to chemical processes by which the injected substance that has become adsorbed in the tissues was converted into sulfide of mercury and weighed.

Fig. 1.



In this way, it was found that the segments adequately supplied with arterial blood are the abdominal part, the entire upper half and the upper two thirds of the lower half of thoracic oesophagus. The segments receiving a poor blood supply were found

Fig. 2.



Schematic representation showing the relative vascularity of the oesophagus (Rabbit)

Showing the distribution of various arteries to the oesophagus (Rabbit)

Fig. 3. Quantitative study of the arteriac blood volume of the human oesophagus (Injection into all of the arteries distributed to the oesophagus.)

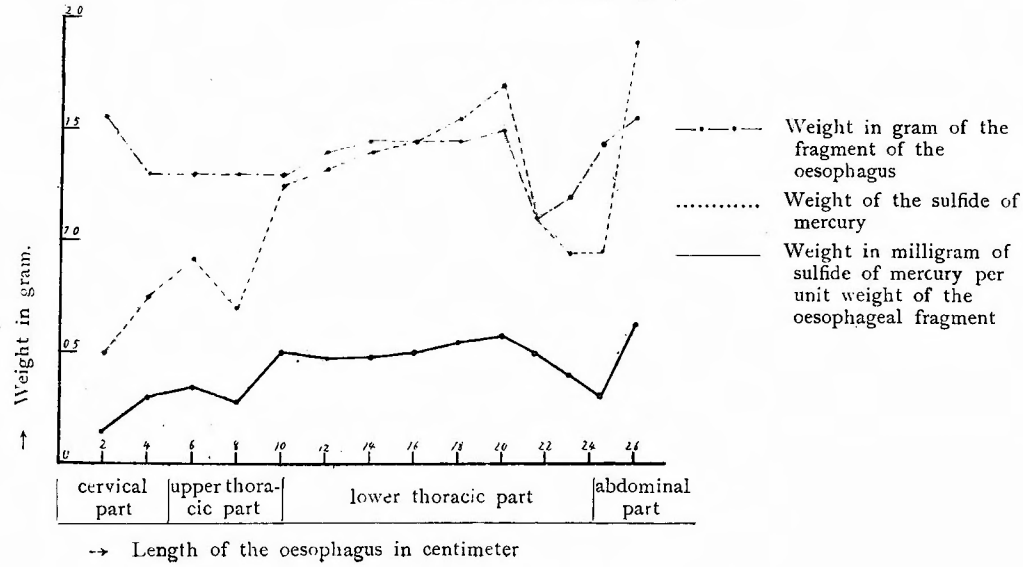


Fig. 4. The same study as in Fig. 3 with preliminary ligation of the intraabdominal arteries to the stomach and the left inferior diaphragmatic artery.

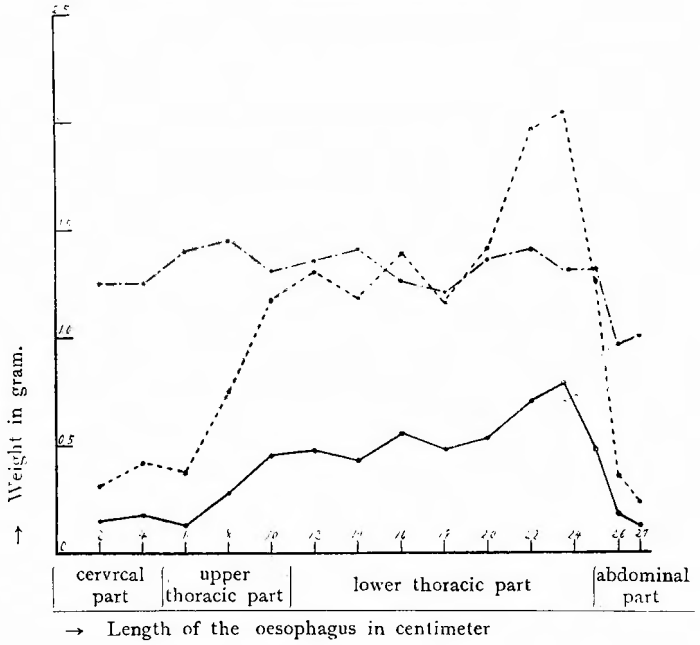
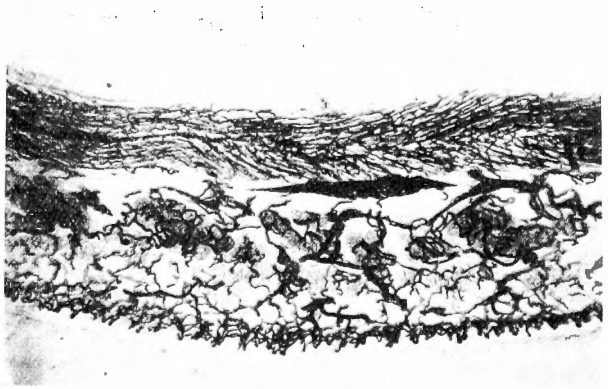


Fig. 5. The oesophagus at the level of the tracheal bifurcation.



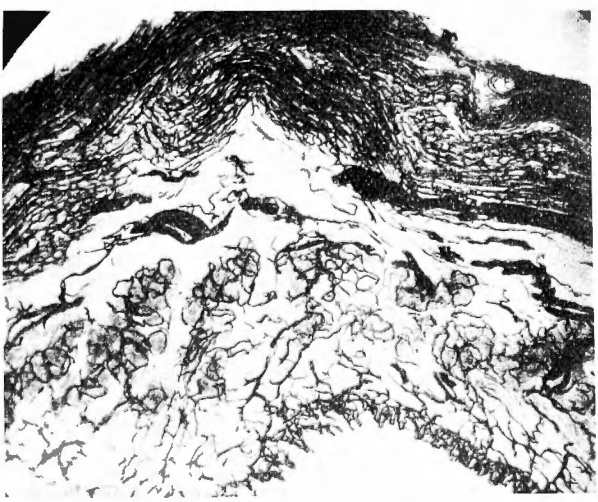
to be the cervical part and the lower segment of the thoracic part, that approximately two centimeters long lying immediately above the diaphragm being especially poor in blood supply and constituting the region of least resistance against operative traumata (Fig. 2, 3). Isolation of the stomach with ligation of the intraabdominal blood vessels distributed to it and of the left inferior diaphragmatic artery causes a diminution of

the blood supply of the lower thoracic and the abdominal parts of the oesophagus to from one third to one fifth of its normal value (Fig. 4)

The results of histological study of distribution of the blood capillaries of the oesophagus in the dog by means of injection of its arteries with india ink were confirmatory to the above observations. (Fig. 5, 6, 7)

Fig. 6. Section from segment within 2 cm. above the diaphragm (region of least resistance).

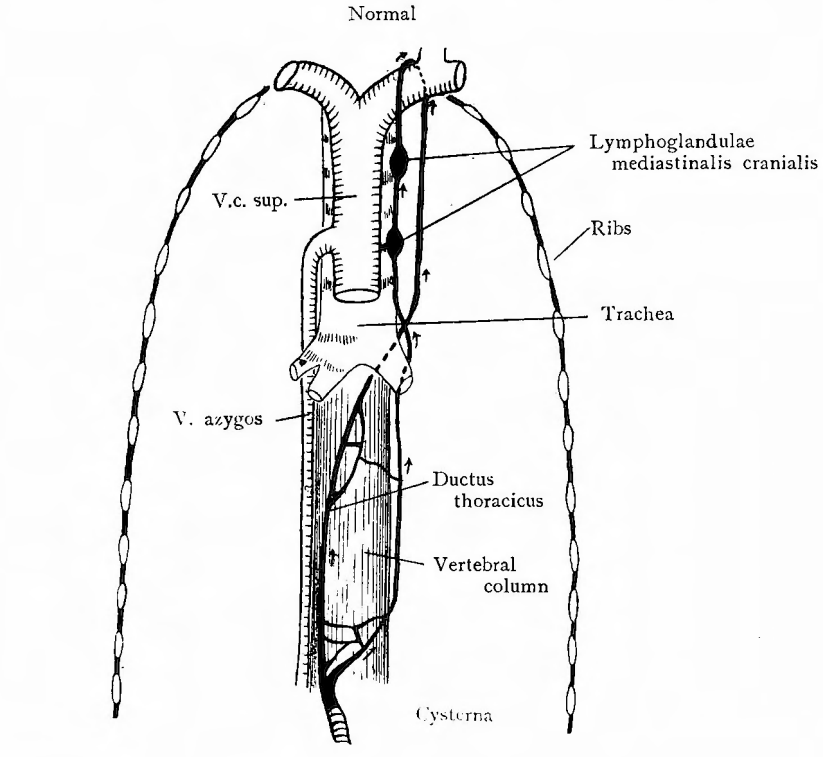
Fig. 7. Abdominal part of the oesophagus.



2. *The Lymphatic System of the Oesophagus.*

A survey of the lmyhatic system of the oesophagus is important in connection with metastasis of malignant neoplasms. We have cautiously removed the cervical and

Fig. 8. Showing altered lymphatic course after ligation of the thoracic duct.



dorsal vertebrae in experimental animals and eight cadavers of foetuses and young infants, exposed the cervical and thoracic parts of the oesophagus, and its lower segments and the abdominal portion were exposed from the abdominal route. Gerota's solution was then injected into the lymphatic vessel, and after fixation with 10% formol solution, the course and distribution of the lymphatics were studied. From the results of this study, the lymphatics of the oesophagus may be divided into five systems; namely,

1) deep cervical group, 2) paratracheal group, 3) tracheobronchial group, 4) posterior mediastinal group, and 5) cardiac group. It should be remembered, however, that a deviation from these normal arrangements will occur in cases of disease process in the oesophageal wall.

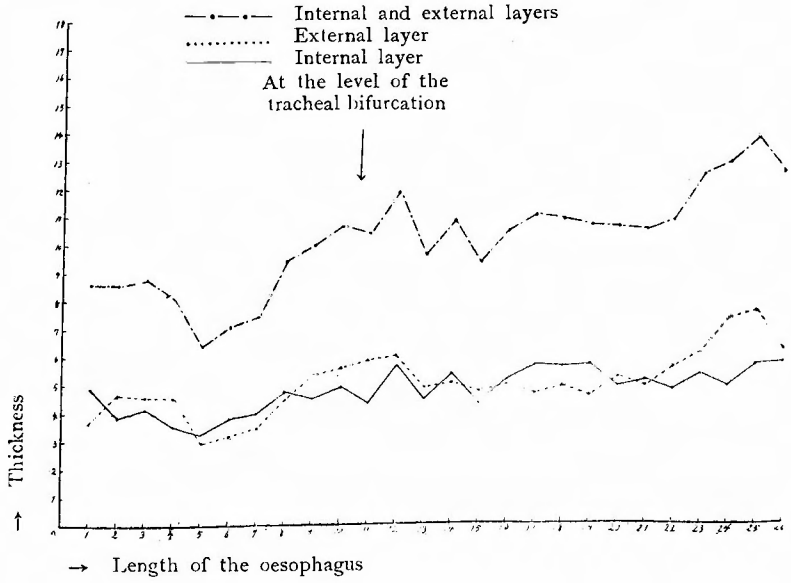
3. *Disturbances of the Thoracic Duct.*

In operation upon the oesophagus and the mediastinum, an injury to the thoracic duct is liable to occur. In order to determine the influences of disturbances of the duct upon lymphatic circulation, we have ligated the thoracic duct of the dog, and after a certain lenght of time sacrificed the animal, injected Gerota's solution and studied the changes in the lymph channels. Of seven dogs in which the thoracic duct was ligated, only one died from empyema thoracis, while the rest of them showed no systemic disturbances whatever and continued to live in perfect health until they were killed. The lymph was conveyed by newly formed collaterals into the left fifth intercostal vein (Fig. 8), the azygos vein, the superior vena cava, and both right and left superior mediastinal lymph glands, or into the posterior intercostal lymphatic vessel.

4. *Histology of the Oesophageal Tissues.*

Of the various tissues composing the oesophagus we have studied its musculature in detail. The cross stricted muscle usually ends at the level of the tracheal bifurcation, but it may rarely extend into the abdominal part. The smooth muscle increases its

Fig. 9. Variation of the thickness of the muscular coat at different segments of human oesophagus. (male, 18 years old.)



thickness as we trace it downward, and at the lower segments of the gullet it reaches twice the thickness of the upper segments. (Fig. 9)

5. *The Nervous Mechanism.*

In studying the physiology of the oesophagus, we have employed a method, hitherto not undertaken, by which muscular contraction of the oesophagus were directly recorded. Our results of various experiments on the vagus innervation were as a whole confirmatory to those obtained by previous workers. In regard to the sympathetic control of the oesophageal function, a uniformity of opinion has been wanting. We have found that a bilataleral extirpation of the superior cervical and stellate ganglia both before and after, but especially after, a unilateral sectioning of the vagus causes an increase in duration of the peristalsis of the cardiac portion. (Table 1, 2, Fig. 10, 11, 12).

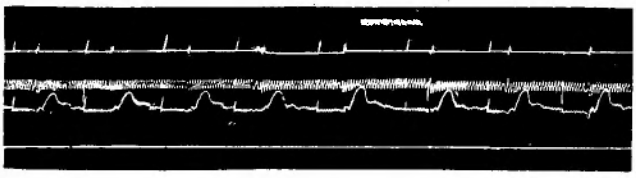
Table 1. Showing changes in time necessary for passage of peristaltic wave through a unit distance of the oesophagus, caused by bilateral extirpation of the superior cervical and stellate ganglia, followed by unilateral vagus section.

Operation / Animal number	Before operation	After bilateral extirpation of the superior cervical and stellate ganglia	% increase over preoperative value	After unilateral vagus section	% increase over the value following ganglionectomy
	second	second		second	
22	0.094±0.0020	0.102±0.0020	8%	0.118±0.0027	15%
32	0.075±0.0007	0.079±0.0007	5%	0.099±0.0020	25%
31	0.075±0.0007	0.082±0.0005	9%	0.091±0.0007	11%
34	0.075±0.0020	0.078±0.0027	4%	0.116±0.0047	32%
17	0.094±0.0014	0.099±0.0014	5%	0.133±0.0021	25%

Table 2. Showing variations in the kymographic curves of the peristalsis of the cardia following bilateral extirpation of the superior cervical and stellate ganglia, and a unilateral section of the vagus nerve

Animal No.	Before section		After bilateral extirpation sup. cervical and stellete ganglia				After unilateral vagus section			
	Width of base line	Height of the curve	Width of base line	Increase over preoperative value	Height of the curve	Increase over preoperative value	Width of base line	Increase or decrease over the value after bilateral ganglionectomy	Height of the curve	Increase or decrease over the value after bilateral ganglionectomy
	mm	mm	mm		mm		mm		mm	
17	2.08±0.053	1.00±0.050	2.12±0.030	+2%	0.96±0.006	−4%	1.00±0.009	−55%	0.63±0.026	−34%
22	2.04±0.031	2.20±0.046	2.19±0.015	+7%	1.02±0.022	−1%	1.66±0.046	−24%	1.36±0.047	−29%
31	2.05±0.017	0.97±0.032	2.26±0.023	+9%	1.00±0.022	+3%	1.58±0.029	−30%	0.60±0.059	−40%
44	1.05±0.017	1.10±0.027	1.08±0.016	+3%	1.07±0.027	−3%	0.73±0.047	−32%	0.76±0.022	−29%
32	1.50±0.015	0.93±0.022	2.00±0.011	+33%	0.75±0.007	−19%	0.82±0.028	−59%	0.50±0.023	−33%

Fig. 10. Kymographic record of peristaltic movements of the normal cardia



H. Peristalsis of the cervical part.
R. Movement of the abdominal
K. part of the oesophagus with respiration.
K. Peristalsis of the cardia.

Fig. 11. Same as above after bilateral extirpation of the stellate ganglia.

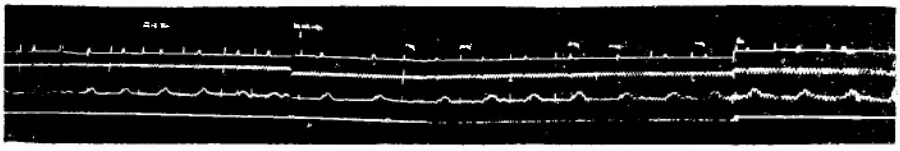
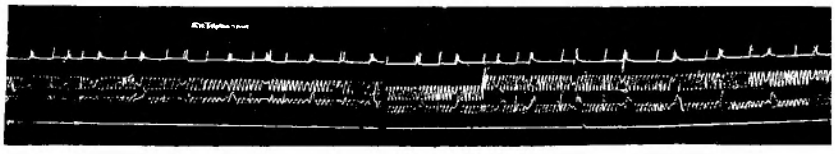


Fig. 12. After unilateral vagus section, followed by bilateral extirpation of the stellate ganglia.

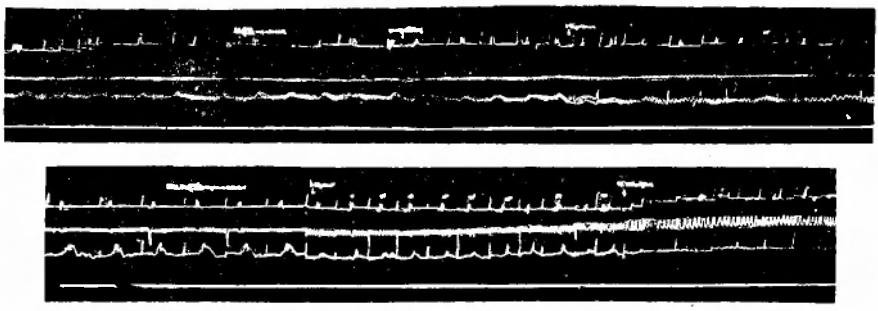


It was further observed that a bilateral extirpation of the splanchnic nerve, the abdominal sympathetics, and the stellate ganglia is followed by a reduction of dilatative movement of the cardiac portion. These facts prove that the sympathetic nerve acts on the cardia in antagonism to, and regulates, the vagus innervation, that is, it limits the dilatation of the cardiac portion. (Table 3, Fig. 13).

Table 3. Showing variations in the kymographic curves of the cardiac peristalsis caused by bilateral exstirpation of the stellate ganglia after bilateral exstirpation of the splanchnic nerve and the solar plexus.

Animal No.	After bilateral extirpation of the splanchnic nerve and the solar plexus.		After subsequent bilateral Exstirpation of the stellate ganglia	
	Width of base line	Height of the curve	Width of base line	Height of the curve
	mm	mm	mm	mm
91	1.5±0.036	0.5±0.022	1.4±0.017	0.4±0.029
94	0.8±0.027	0.6±0.030	0.6±0.024	0.5±0.028
95	0.7±0.030	0.6±0.022	0.6±0.032	0.5±0.057
90	0.8±0.046	0.5±0.051	0.7±0.016	0.5±0.053

Fig. 13. After a bilateral extripation of the splanchnic nerve, followed by a unilateral vagus section and bilateral extirpation of the stellate ganglia.



Chapter II. Experiments Concerning the Thoracotomy.

1. Introductory remarks on thoracotomy.

Problems concerning thoracotomy are fundamental in the oesophageal surgery. These problems seemed apparently to have been solved by introduction by Sauerbruch in 1904 of the technic under differential pressure, but in reality such was not the case. For over twenty years since Sauerbruch's work appeared, the progress of the thoracic surgery, particularly under differential pressure, has been lamentably slow. The principle set forth at the outset of this paper, namely that the differential pressure is not only unnecessary but is actually a hindrance has not been recognized, and the progress of the surgery of the chest cavity has been consequently at a stand still.

We believe that the work we have been doing in our clinics on thoracotomy under normal atmospheric pressure has completely solved the problem. Our observations on over ninety cases which were operated upon without the differential pressure apparatus speak eloquently in its confirmation. As the tables 4 and 5 show, the free thoracotomy or thoracotomy under the normal atmospheric pressure has been applied with safety in performing various operations on diverse diseases within the thoracic cavity.

2. Relation betweeen Thoracotomy and the Pulmonary Function.

The fact that the functional loss of the lung on the side of the operation in free thoracotomy is sufficiently compensated for by the unopened side has been proved by the experimental work reported by Dr. Kudo* (1925). Further studies on the postoperative pulmonary function subsequently carried out in our laboratories by means of Knipping's apparatus have shown that in the rabbit whose left thorax was opened under differential pressure (pressure of 7 cm. of water column), the respiratory function immediately after the operation is nearly normal, but as time goes on the phenomena of

* Archiv für japanische Chirurgie Bd. 2, 1925 (Japanese and German.)

Table 4. Classification of thor cotomy cases according to diagnosis.

Diagnosis	Total number of cases operated upon	Free thoracotomy done on	Free transdiaphragmatic thoracolaparotomy done on	Free transdiaphragmatic laparothoracotomy done on	Free thoracolaparotomy done on	Free laparothoracotomy done on
Carcinoma of oesophagus	33	25	5	2		1
Carcinoma of cardiac part of oesophagus	2		2			
Carcinoma of cardia	14	1	2		2	9
Carcinoma of st mach	3		2			1
Carcinoma of lung	1	1				
Cardiospasm	1		1			
Neurogenic stenosis of oesophagus	2	1				1
Idiopathic oesophageal dilatation	7		7			
Myoma of oesophagus	(1)		(1)			
Oesophagus elongatus	2		1			1
Oesophagitis	1	1				
Mediastinal tumor	4	4				
Sarcoma	4	4				
Tuberculosis of the lung	7	7				
Intrathoracic cold abscess	1	1				
Foreign body in the oesophagus	1					1
Foreign body in the thoracic cavity	2	2				
Foreign body in the bronchus	1	1				
Chondroma of the chest wall	1	1				
Fracture of the rib	1	1				
Raynaud's disease	1	1				
Thromboangeitis obliterans	1	1				
Metastatic lymphosarcoma	1	1				
Diaphragmatic hernia	1					1
Grand total	92	53	20	2	2	15

pulmonary insufficency manifest themselves, and 48 hours postoperatively the conditions of gas exchange show no evidence of recovery. In the rabbit whose chest was opened on the left side under normal atmospheric pressure, on the other hand, the respiratory

Table 5. The number of cases operated upon under free thoracotomy.

Type of operation	Number of cases
Exploratory thoracotomy	46
Removal of foreign bodies (with gastrotomy)	5 (1)
Extirpation of neoplasms	5
Oesophagoplasty or Oesophagocardioplasty (Preceded by extirpation of myom)	8 (1)
Separation of pulmonary adhesion in tuberculosis	7
Extirpation of intrathoracic sympathetic ganglia	3
Einstülpungsresektion	2
Total gastrectomy and oesophago-jejunostomy	2
Oesophago-gastrostomy (with resection of the cardia)	4 (2)
Resection of the oesophagus	5
Anterior and posterior mediastinotomy	9
Radical operation for diaphragmatic hernia (closure of hernial opening, reduction of the herniated viscera)	1
Total (Ages of the patients from 7 months to 68 years)	92

Table 6. Average postoperative value and percentage of respiratory gas exchange.

	Volume respired		Volume inspired		Volume expired		CO_2/O_2 ratio	
	actual value	percentage	actual value	percentage	actual value	percentage	actual value	percentage
Normal control	2142.61	100.0	1194.73	100.0	972.11	100.0	0.81	1.00
Free thoracotomy	2379.53	110.7	1298.15	108.6	1066.33	110.8	0.82	1.01
Thoracotomy under differential pressure	2615.08	120.0	1486.98	124.6	1119.74	115.1	0.75	0.92
Differential pressure utilized only at the time of closing the wound	2569.32	119.5	1424.37	120.0	1149.78	118.2	0.81	1.00

function returns to its normal state three hours after the operation and no pulmonary impairment appears subsequently. When the differential pressure was utilized only at the time of closing the thoracotomy wound, the results stand midway between the above two conditions (Table 6, Fig. 14). Identical experiments performed on the right side of the thorax have brought forth the results that are identical with the above, except that the return to the normal following the operation was delayed. Prolonged postoperative observations have shown that in the free thoracotomy series, there is a transient disturbance of the pulmonary function on the fifth or sixth day after the operation, but an eventual recovery is complete. With the use of differential pressure, on the other hand,

Fig. 14. Pulmonary functions immediately after thoracot my.

——— I Control determination on healthy subjects
- - - - - - - II Cases subjected to free thoracotomy
—•—•— III Cases subjected to thoracotomy under differential pressure
.... IV Differential pressure utilized only at closure of the wound

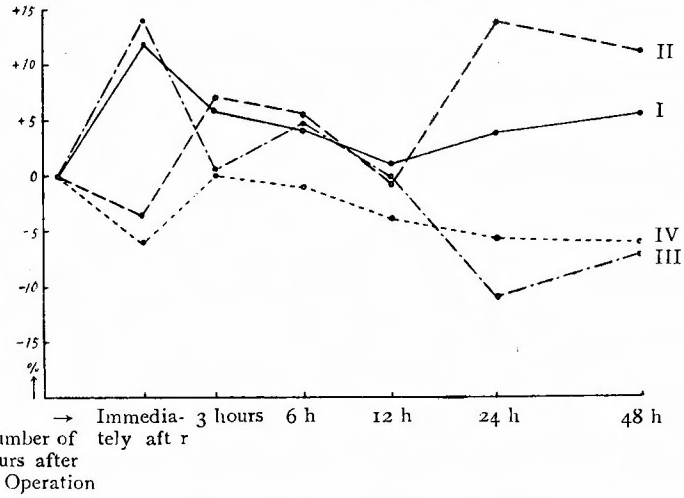


Table 7. Respiratory function after nnilateral free thoracotomy combined with aspiration of intrapleural air. average percentage of 3 animals

	A.Z.	A.V.	A.T.	O_2	CO_2
Preoperative	1.00	1.00	1.00	1.00	1.00
1st day postoper tive	1.67	1.47	0.88	1.48	1.29
2nd day ,,	1.05	0.96	0.90	0.93	0.89
3rd ,, ,,	0.98	0.96	0.97	0.97	0.92
4th ,, ,,	1.01	0.98	0.96	0.93	0.86
5th ,, ,,	0.94	0.99	1.04	0.92	0.75
6th ,, ,,	0.94	0.98	1.03	0.78	0.76
7th ,, ,,	0.94	0.97	1.01	0.93	0.89
8th ,, ,,	0.94	0.91	0.96	0.91	0.84
9th ,, ,,	0.96	0.97	1.01	0.94	0.87
10th ,, ,,	0.90	0.89	0.97	0.90	0.88
11th ,, ,,	0.91	0.92	1.00	0.91	0.81
12th ,, ,,	0.93	0.97	1.04	0.99	0.94
13th ,, ,,	0.94	0.92	0.97	0.97	0.94
14th ,, ,,	0.91	0.95	1.04	1.02	0.95
15th ,, ,,	0.90	0.00	0.99	0.94	0.82
20th ,, ,,	0.91	0.95	1.02	0.94	0.95

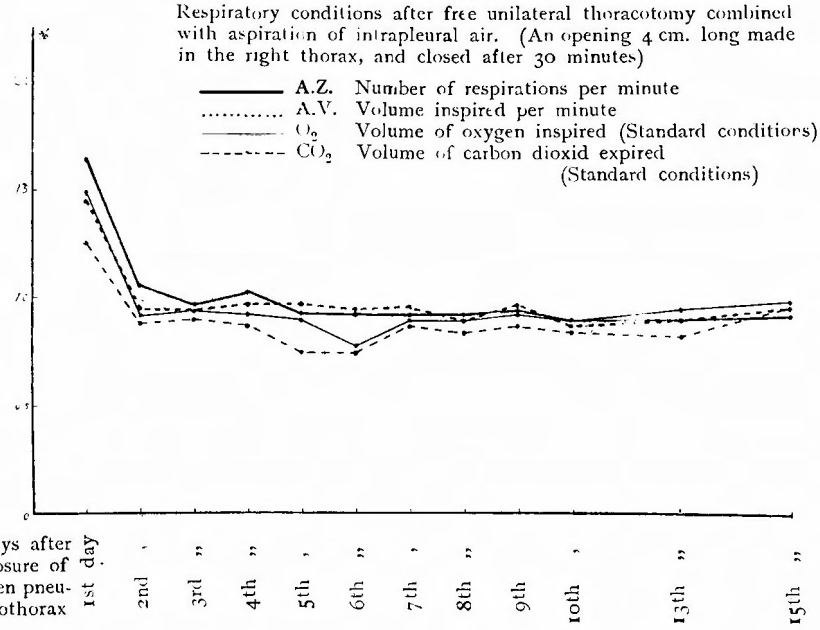
A.Z. Number of respirations per minute
A.V. Volume of respiration per minute.
O_2 Volume of oxygen inspired per minute.
Co_2 Volume of carbon dioxide expired per minute

Table 8. Pulmonary function after unilateral thoracotomy under differential pressure, with average percentage of 3 animals.

*	A.Z.	A.V.	A·T.	O_2	CO_2
Preoperative	1.00	1.00	1.00	1.00	1.00
1st day postoperative	1.10	1.11	1.00	1.09	1.04
2nd ,, ,,	1.08	0.96	0.88	0.88	0.76
3rd ,, ,,	1.16	0.87	0.75	0.83	0.80
4th ,, ,,	1.09	0.90	0.83	0.85	0.84
5th ,, ,,	0.96	0.74	0.80	0.78	0.69
6th ,, ,,	0.87	0.75	0.85	0 62	0.59
7th ,, ,,	0.85	0.77	0.88	0.66	0.60
8th ,, ,,	0.85	0.74	0.90	0.62	0.65
9th ,, ,,	0.84	0.71	0.84	0.71	0.64
10th ,, ,,	0.81	0.66	0.82	0.61	0.54
11th ,, ,,	0.80	0.66	0.82	0.52	0.57
12th ,, ,,	0.81	0.65	0.80	0.47	0.46
13th ,, ,,	0.81	0.65	0.76	0.52	0.53
14th ,, ,,	0.79	0.63	0.83	0.52	0.51
15th ,, ,,	0.77	0.62	0.80	0 43	0.43
20th ,, ,,	0.74	0.67	0.89	0.40	0.38

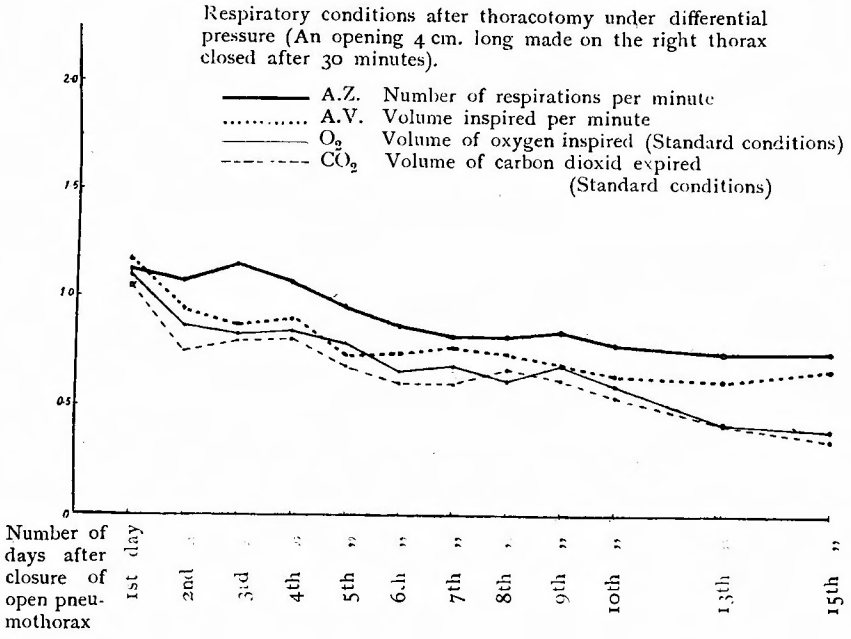
* Foot note: See table 7.

Fig. 15.



the conditions of the pulmonary function become progressively worse until about the third week, when the impairment becomes so marked as to cause a pronounced wasting of the animal. These results are constant in all the animals on which simple thoracatomy or other intrathoracic operations are performed by the two methods described. (Table 7, 8, Fig. 15, 16)

Fig. 16.

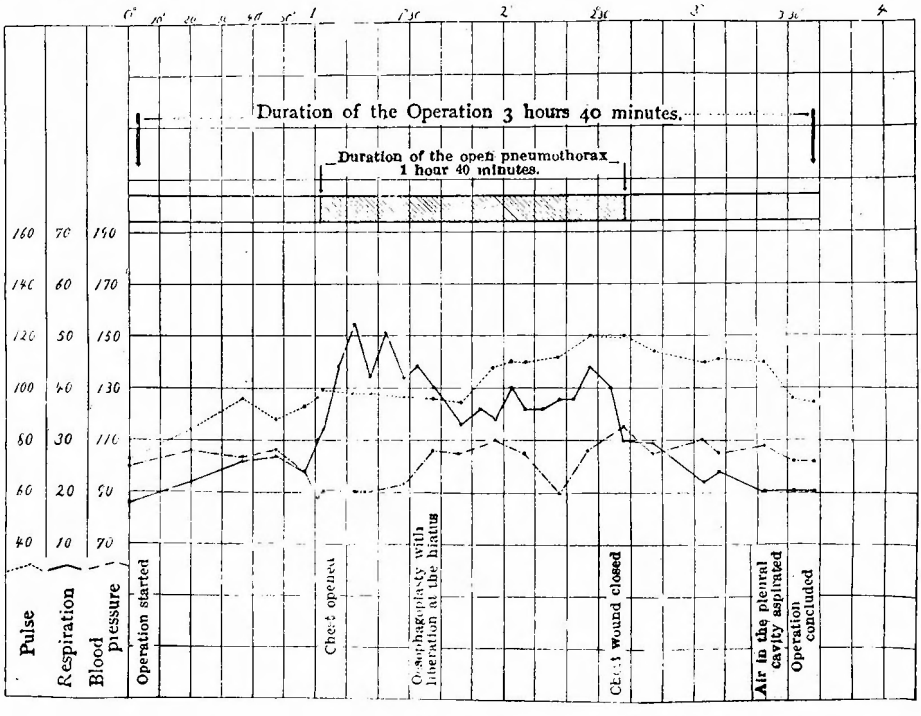


Experimental results on the blood gas exchange and the intrathoracic pressure also prove that the free thoracotomy is much less deleterious than that under differential pressure.

3. The Relation between Thoractomy and the Respiratory Function in Man.

Close observations on the respiratory conditions in clinical cases which were subjected to free thoracotomy have shown that the majority of the patients present a transient respiratory disturbance at the moment when the chest cavity is opened, and that in a very few, the respiration ceases abruptly for a brief period. During the remainder of the duration of the open pneumothorax, the rate of respiration remains high but its quiet rhythm is maintained. After closing the thoracotomy wound, the respiratory conditions improve considerably and the rate decreases in comparison to that during the open pneumothorax in the majority of cases. Aspiration of the residual air in the pleural cavity further reduces the respiratory frequency. (Fig. 17) These conditions

Fig 17.



Patient T. S. ♂, Idiopathic dilatation of the oesophagus.

are not influenced by the type of anaesthetics used, the site of the operation, the size of the opening made, or the duration of the open pnemothorax. In practically half of the cases in which local anesthesics were employed, the effects on the respiration were in no way different from those in which general anesthesia was used. Regarding the site at which the chest cavity is entered, we have tried both anterior, posterior, left, right aspects, or through the diaphragm or the upper thoracic bonndary. The size of the opening made measured from 25 cm.×15 cm. at most to less with various gradations when smaller operative field sufficed. The duration of the open pneumothorax was in the majority of operations one hour more or less, the longest being 3 hours and 40 minutes which, however, was not followed by noticeable deleterious effects. (Table 9)

We have attempted to determine if there is any relationship between the structural characteristics of the thorax and the respiratory conditions during and after the free thoracotomy, and found that neither the size of the antero-posterior measurement of the mediastinum nor the ratio between its side to side and the antero posterior measurements has any definite bearing upon the respiratory function. (Table 10)

Table 9. The side of the chest chosen, the form of anesthesia, the size of the opening, and the duration of open pneumothorax in the cases upon which free thoracotomy was performed.

	Number of cases	Total
Anesthesia:		
General anesthesia	16	
Combined local and general anesthesia	19	
Local anesthesia	57	92
The duration of open pneumothorax:		
Less than one hour	58	
Between one and two hours	26	
More than two hours*	8	92
* The longest duration 3 hours and 40 minutes		
The size of the opening made:		
Not larger than 19×6 cm.	19	
Not larger than 20×12 cm.	63	
Not larger than 24×16 cm.	10	92
The side of the chest chosen:		
Left	71	
Right	21	92

Table 10. The relation between the structural forms of the chest and the respiratory conditions during operation.

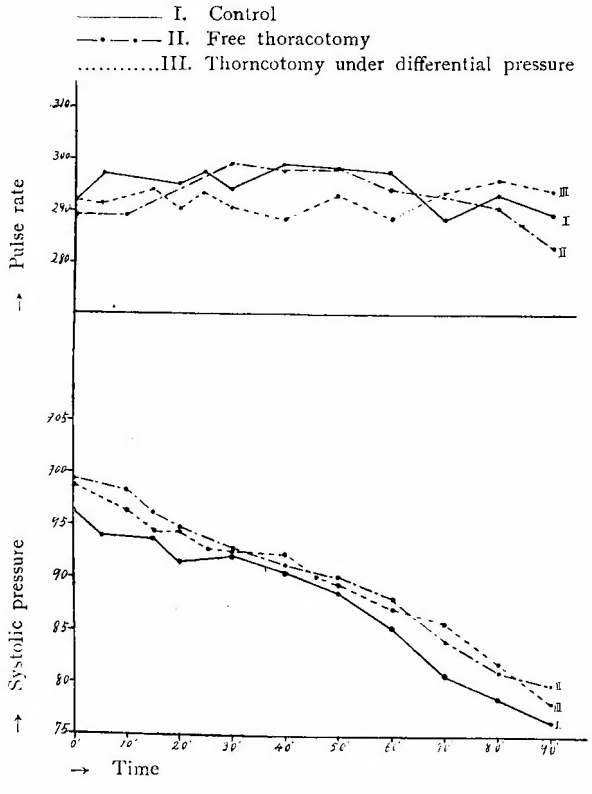
	Name of patient	Type of operation done	Antero-posterior diameter of the chest	Antero-posterior diameter of mediastinum	Lateral diameter of the chest	Respiratory condition during open pneumothorax
Right-sided thoracotomy	M.	Posterior mediastinotomy	18	11.5	27	Slightly disturbed
	I.	Posterior mediastinotomy	21	12.3	28.8	Not disturbed
	O.	Exploratory thoracotomy	15	8.1	28.5	Disturbed
	A.	Exploratory thoracotomy	18.7	10.8	28	Slightly disturbed
	K.	Transpleural displacemt of the oesopphagus	17	10	25	Not disturbed
	O.	Resection of the oesophagus by penetration method	19.2	11.1	29	Not disturbed
	I.	Partial exclusion of the oesophagus	18	11	26.5	Not disturbed
Left-sided thoracotomy	U.	Exploratory thoracotomy	20.6	11.4	28.5	Slightly disturbed
	Y.	Exploratory thoracotomy	18 5	11	27	Slightly disturbed
	K.	Exploratory thoracotomy	19.2	12	29.8	Not disturbed
	T.	Oesophagoplasty	18	11	30.5	Not disturbed
	M.	Exploratory thoracotomy	20	12	28	Slightly disturbed
	Y.	Separation of adhesion of the pulmonary pleura	18	10.4	30	Slightly disturbed
	S.	Oesophagoplasty	18	12	29.3	Not disturbed
	K.	Exploratory thoracotomy	19.6	10.6	29	Disturbed

It was further noted that in free thoracotomy done on the right side, the mediastinum moves towards the left, but the fluttering of the mediastinum causing dangerous symptoms of cardiac or respiratory disturbances does not occur in any instance. So-called dangers from mediastinal fluttering is, therefore, nothing more than a phantasy.

4. Influences of Thoracotomy upon the Function of the Heart.

In order to study the cardiac function in thoracotomy, rabbits were thoracotomized both under differential and normal atmospheric pressure, and the systolic blood pressure, and the number of heart beats per minute before, during, and after the operation were determined. In open pneumothorax, the systolic blood pressure rises and the cardiac

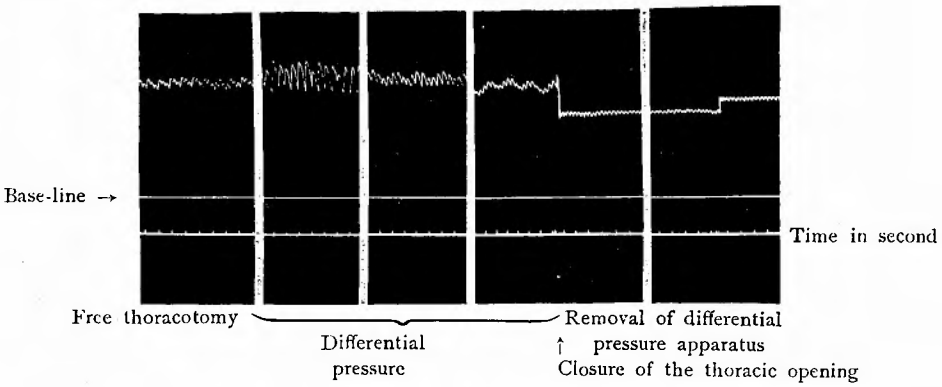
Fig. 18. Graphic curve showing the behavior of the systolic blood pressure and pulse rate during the left sided unilateral thoracotomy. (The reading made every minute.)



rate decreases with consequent circulatory disturtance irrespective of the side of the chest opened and of whether the differential pressure is utilized or not. But the degree of the circulatory impairment in the left sided free thoracotomy is less than that in

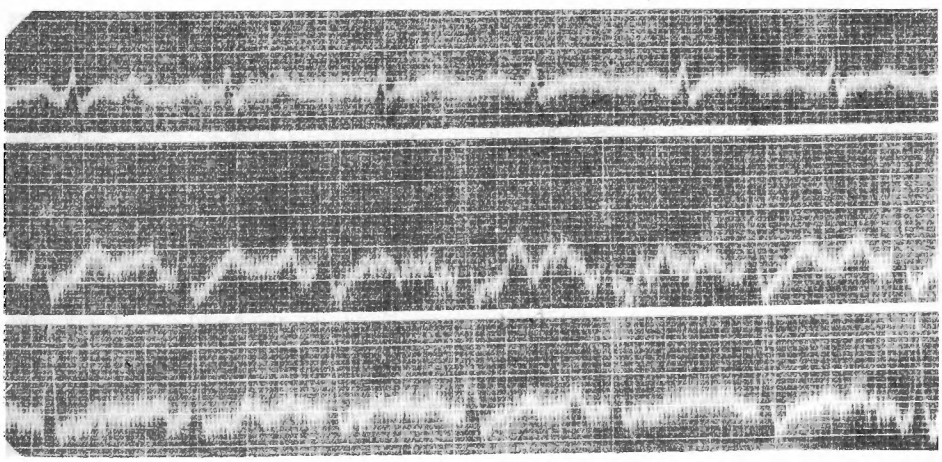
the differential pressure series. When the open pneumothorax is created on the right side, the cardiac impairment during the operation is greater in the free tharacotomy than that under differential pressure, but in the postoperative periods this relation is exactly reversed and there is no noticeable disturbance following the free thoracotomy. (Fig. 18, 19)

Fig. 19. Kymographic record of the blood pressure and pluse during the free thoracotomy and closure of the thoracic opening under differential pressure.



Electro-cardiographic studies show left sided preponderance in right sided thoracotomy and right sided preponderance in the left sided operation. During the latter operation, it was shown that the duration of the heart beat, of the ventricular contraction and of the pause is lengthened. No difference was noted electrocardiographically between the free thoracotomy and that under differential pressure.

Fig. 20. An electrocardiogram during a free thoracotomy in man (before free thoracotomy).



In man electrocardiogram does not show a unilateral preponderance as in the animal, owing to the fact that the mediastinum in man does not shift as in the lower animals. (Fig. 20, 21, 22).

Fig. 21. An electrocardiogram during a free thoracotomy in man (during free thoracotomy).

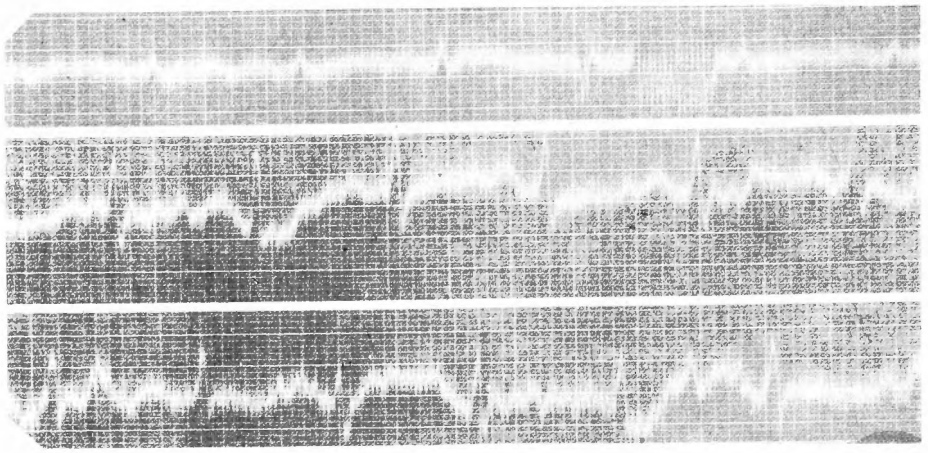
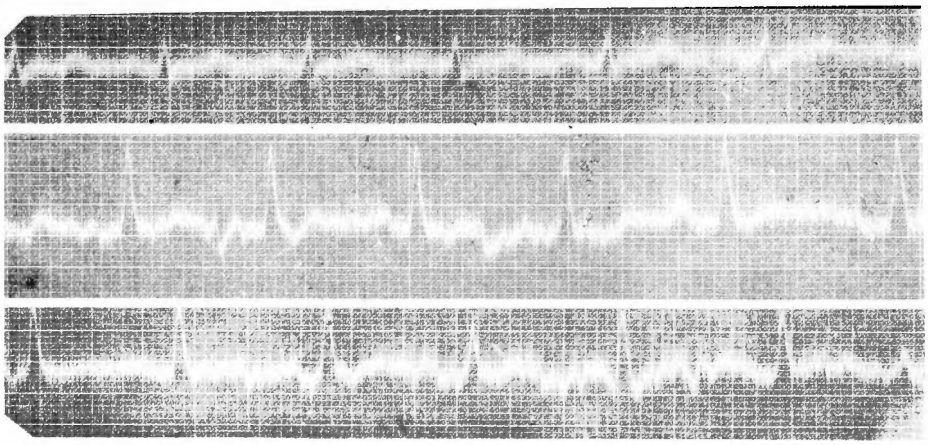


Fig. 22. An electrocardiogram during a free thoracotomy in man (after free thoracotomy).



In man, the blood pressure is lowered, the pulse rate increased, and the amplitude of the pulse decreased in the majority of cases five minutes after free thoracotomy; the next in frequency being those cases which show an increased blood pressure, increased pulse rate and amplitude. To state these facts more accurately, the blood pressure stays either normal or shows an upward or downward variation, between 10 and 30 mm. Hg., the pulse rate either remains unaltered or increases or decreaes

between 10 and 30 beats per minute, and the pulse pressure either remains unchanged or varies upoward or downward to the extent of from 10 to 20 mm. Hg., in other words, the great majority of cases do not show any marked changes during or after the free thoracatomy. The blood pressure most frequently returns to the preoperative level in about one week's time after the operation. The pulse rate returns to the normal frequency in two or three days' time. When the operation ends as merely an exploratory one or the intrathoracic operative procedure a simple one, the blood pressure, pulse rate and the pulse pressure usually remain unaltered, such findings being more frequent in the left sided than the right sided operations.

In intrathoracic operations the heart is frequently exposed to pressure and displacement. That these factors would extert a deleterious effect upon the cardiac function is readily conceivable, but our experiences further indicate that the pressure upon the auricle is far more detrimental than that upon the ventricle. (Fig. 23).

Fig. 23. Sphymographic record showing the effects of pressure exerted directly upon the heart (left sided thoracotomy)
The atrium was forcefully pressed upon.

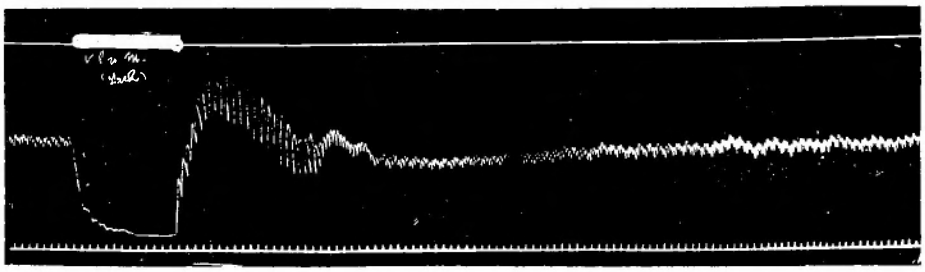


Table 11. Pigment excretion by the liver in thoracotomy (Azorubin S).
(Quantity of the pigment 2 cc.).

	Excretion by the liver of the pigment injected 30 minutes after free thoracotomy		Excretion by the liver of the pigment injected 30 minutes after thoracotomy under differential pressure	
Pigment detected first	1′	32″	2′	10″
Time required before maximum concentration is reached	0′	30′	15′	30′
Maximum concentration		0.38		0.34
The length of time the pigment is concentrated sufficient for colorimetry		67.5		82.5
Quantity excreted in the first hour		67		54.8
Quantity excreted in the second hour		0.3		1.6
Total quantity excreted		67.2		56.3
Quantity excreted in urine		75.5		75.1

5. *The Influences of Thoracotomy upon the Hepatic Function.*

In order to find out the inluences of thoracotomy upon the functions of the liver which is intimately related to the respiratory and circulatory systems, we have studied the conditions of the pigment excretory (Azorubin S) and the blood sugar regulatory function of the liver in thoracotomy both free and under differential pressure. (Table 11). The blood sugar was studied according to Hagedorn-Jensen's method. These two functions were found to be practically unimpaired, except that for thirty minutes after the operation under differential pressure, the pigment excretory function was found to be interfered with, indicating that the differential pressure causes a postoperative passive congestion of the liver. (Table 12)

Table 12. The sugar tolerance tests on thoracotomized rabbits.

	Time after thoracotomy	Blood sugar value before injection of glucose	Blood sugar value after injection of glucose				
			5′	20′	35′	50′	65′
Free thoracotomy	2 hours	134	211	176	144	131	114
	24 ,,	111	193	164	141	129	117
Thoracotomy under differential pressure	2 ,,	128	200	150	139	126	116
	24 ,,	108	198	158	129	118	114

Chapter III. Changes Produced by Thoracotomy upon the Blood.

1. *The Blood Picture.*

Studies on the blood picture carried out repeatedly before and after free thoracotomy on twenty-two clinical cases have shown that the changes produced are essentially similar to those observed following a laparotomy. In general, leucocytes are increased, and erythrocytes decreased. Of the leucocytes, the lymphocytes, eosinophiles, and mononuclears are decreased, while the polymorphonuclear neutrophiles and the transitional forms are increased. The effects of thoracotomy on the blood picture indicate that the burden on the body economy caused by the operation is not much heavier than that of laparotomy.

2. *Hydrogen Ion Concentration.*

Changes in hydrogen ion concentration and its neutralization in the blood which might be caused by thoracotomy were investigated in the rabbit by means of Micheaelis' method. The results obtained show that PH decreases immediately after the operation but that the reduction lies within the normal limit both when differential pressure was employed and not.

3. *The Rate of Sedimentation of Erythrocytes.*

Although the erythrocyte sedimentation either remains unaltered in the rabbit during thoracotomy or tends rather to be retarded, yet twenty four hours after the opeation it becomes greatly accelerated, reaching the maximum rate on the third or fourth post-operative day. It then begins to come down until it returns to the preoperative value in the course of two weeks after the operation. This course of events holds both for free thoracotomy and thoracotomy under differential pressure, but the acceleration that occurs twenty-four hours after the operation is more pronounced in the latter form of thoracotomy than in the former. This fact is explainable by assuming that greater detriments are exerted on the lung tissue and the general system by high pulmonary pressure, bringing about more intense changes in the physical, or chemical state of the blood either by a transient inflammation or by absorption of cellular detritus.

4. *Blood Sugar.*

In our series of clinical cases of free thoracotomy, the blood sugar determination by Seifert's colorimetric method has shown an hyperglycaemia of from 1.2 to 2.5 times the normal value, or the average of 1.7 times the normal value. But it must be re-memembered that this value does not represent the extent of the disturbance of the blood sugar metabolism by the operative procedure alone, since we have to take into

Table 13. The blood sugar content in free thoracotomy.

Name of patient	Diagnosis	Duration of operation	Duration of open pneumothorax	Blood sugar before operation	Blood sugar during operation	Blood sugar immediately after operation
				mg.%	mg.%	mg.%
H.	Carcinoma of the oesophagus	2° 20′	60′	100		125
O.	,,	1° 40′	12′	80		100
W.	,,	1° 20′	33′	85	135	150
S.	Carcinoma of the cardia	1° 25′	20′	60		150
K.	Carcinoma of the oesophagus	1° 40′	50′	75	135	135
A.	,,	1° 55′	22′	75		125
Y.	Mediastinal tumor	3° 00′	26′	125	300	250
N.	Carcinoma of the oesophagus	3° 05′	33′	75	200	150
U.	,,	3° 05′	60′	100	450	175
Y.	Pulmonary tuberculosis	1° 50′	16′	125		185
Y.	Carcinoma of the oesophagus	2° 40′	54′	100	140	180
I.	,,	5° 05′	20′	120	230	190

consideration the psychic element in the operation performed under local anaesthesia and also the influence on the sugar balance exerted by the administration of approximately

Table 14. The basal metabolism in free thoracolaparotomy

Name of the Patient	Diagnosis	Time tests made	O_2	CO_2	R.Q.	G U.	Increase (+) or Decrease (−)
Left-sided free thoracolaparotomy							
T.E. ♀	Foreign body in oesophagus	Preoperative	1.88	1.12	0.66	1277	
		58 days postoperative	1.97	1.32	0.68	1325	+19% +25%
T.O. ♂	Carcinoma of the oesophagus	Preoperative	2.27	1.45	0.65	1457	
		69 days postoperative	1.75	1.37	0.78	1131	+21% −0.5%
		92 days postoperative	1.70	1.38	0.81	1199	+ 7%
H.O. ♂	Carcinoma of the oesophagus	Preoperative	1.93	1.50	0.78	1351	
		10 days postoperative	1.80	1.42	0.79	1262	+71% + 2%
		29 days postoperative	1.69	1.37	0.81	1191	+13%
T.F. ♂	Elongatio oesophagi	Preoperative	2.40	1.94	0.80	1693	
		30 days postoperative	1.83	1.44	0.78	1288	+41% +11%
K.H. ♂	Carcinoma of the oesophagus	Preoperative	1.94	1.33	0.69	1336	
		52 days postoperative	2.18	1.40	0.62	1489	+21% +57%
W.M ♂	Carcinoma of the cardia	Preoperative	2.03	1.59	0.78	1426	
		28 days postoperative	1.83	1.37	0.73	1303	+ 25% +17%
Y.T. ♂	Idiopathic dilatation of the oesophagus	Preoperative	2.27	1.73	0.76	1497	
		31 days postoperative	2.24	1.81	0.80	1576	+14% +17%
Left-sided free thoracotomy							
K.U. ♂	Carcinoma of the oesophagus	Preoperative	1.63	1.38	0.85	1156	
		17 days postoperative	1.66	1.45	0.78	1186	+ 4% +12%
S.S. ♂	Oesophagitis	Preoperative	2.62	1.63	0.62	1776	
		13 days postoperative	2.51	1.79	0.71	1733	+28% +30%
Right-sided free thoracotomy							
S.K. ♂	Carcinoma of the oesophagus	Preoperative	1.79	1.24	0.69	1277	
		13 days postoperative	1.48	1.12	0.74	1070	+25% + 8%
		22 days postoperative	1.76	1.20	0.68	1209	+28%
B.A. ♂	Carcinoma of the oesophagus	Preoperative	1.93	1.31	0.68	1328	
		11 days postoperative	1.87	1.44	0.77	1307	+17% +15%
		18 days postoperative	1.61	1.30	0.80	1336	+17%
T.Y. ♂	Oesophagitis	Preoperative	2.06	1.44	0.70	1420	
		25 days postoperative	1.90	1.52	0.80	1335	+22% +17%

consideration the psychic element in the operation performed under local anaesthesia and also the influence on the sugar balance exerted by the administration of approximately

1 cc. adrenalin with the local anaesthetic to each individual. Furthermore, in the usual laparotomy cases hyperglycaemia of from 1.1 to 2.5 times the normal or the average of 1.8 times the normal value is found. Such results would indicate that the free thoracotomy is a surgical procedure not greater in its effect on the blood sugar metabolism than the laparotomy. (Table 13) This relationship between the sugar metabolism and thoracotomy agrees in general with that between thoracotomy and hepatic function, hydrogen ion concentration, and erythrocyte sedimentation test.

5. *Influences of Thoracotomy Upon the Basal Metabolism.*

We have estimated the basal metabolism of the patients before and after free thoracotomy by means of Knipping's apparatus. The basal metabolic value is lowered for a certain length of postoperative period, but the extent of the reduction would naturally vary with the magnitude of the operative procedure, and for this reason, any standard that would be tenable must be determined by a large number of cases of equal surgical procedure. However, it may be stated that the basal metabolism returns approximately to normal in a course of ten days. (Table 14)

Chapter IV. The Relation between Thoracotomy and the Pleura.

1. *The Power of Absorption of the Pleura.*

That the absorption by the pleura is impaired immediately after thoracotomy has been recognized by the previous investigators. We have injected uranin into the rabbit's pleural cavity, and estimated its absorption by quantitative determination of the dye excreted in the urine and the aqueous humor. The results of this study have shown that 3 days after free thoracotomy the absorption from the pleural cavity is either equal or superior to that of the normal and is not different from that after thoracotomy

Table 15. The pleural absorption.

	7 days after thoracotomy				Normal control	3 days after thorcotomy			
	free thoracotomy	followed by aspiration of pleural air	thoracotomy under differential pessure	free thoracotomy followed by intrapleural injection of blood		free thoracotomy	free thoracotomy followed by aspiration of pleural air	thoracotomy under differential pressure	free thoracotomy followed by intrapleural injection of blood
Quantity uranin injected	3.9	4.0	3.7	3.8	4.0	4.9	4.0	3.9	4.4
Average concentration in aqueous humor	47.1	46.9	31.4	45.6	21.1	21.1	37.1	30.7	32.6
Uranin excreted by urine in 3 hours	28.3	32.1	32.1	24.4	20.8	15.8	13.5	17.6	60.4
Average concentration in the blood	78.8	71.3	71.9	77.4	50.2	67.3	72.5	60.4	61.6

under differential pressure, but that 7 days after the operation the absorption in those which were operated upon under the normal atmospheric pressure is far superior to that under differential pressure, and that the presence of free blood in the pleural cavity unfavorably influences absorption. (Table 15, 16)

Table 16. Pleural absorption.

		7 days after					3 days after			
		free thoracotomy	free thoracotomy followed by aspiration of pleural air	thoracotomy under differential pressure	free thoracotomy followed by intrapleural injection of blood	Normal control	free thoracotomy	free thoracotomy followed by aspiration of pleural air	thoracotomy under differential pressure	free thoracotomy followed by intrapleural injection of blood
Quantity of uranin injected		3.9	4.0	3.7	3.8	4.0	4.0	4.0	3.9	4.4
Right	Volume of liquid	0.4	0.5	0.2	0.2	0.4	0.4	0.4	0.4	0.2
	Uranin concentration	0.5	0.2	0.1	0.2	1.4	0.5	0.5	0.5	0.4
Left	Volume of liquid	3.0	3.4	4.4	3.7	3.8	5.4	6.0	6.0	6.9
	Uranin concentration	3.5	4.8	8.8	4.0	27.1	13.2	13.3	14.9	17.3

2. *The Pleural Infection.*

The fact that the pleura possesses very little resistance to infection, especially when its physiological integrity is disturbed, is well known. This fact is of considerable importance in the thoracic surgery, and in the surgery of the oesophagus in particular. Of seventy-three cases of experimental gastro-oesophagostomy and oesophago-jejunostomy, infection occurred in twenty-nine, and in nineteen of these there was empyema thoracis which was not caused by perforation. The seriousness of pleural infection in operations involving the oesophagus, the stomach and the intestine within the thoracic cavity may be imagined from these figures.

Our experiments on the rabbits have shown that the presence of residual pneumothorax after thoracotomy favored infection. Thus, when free thoracotomy was not followed by aspiration of air from the pleural cavity, an infection occurred more frequently than when the air was aspirated. It was also noted that thoracotomy under differential pressure was followed by a higher incidence of infection than free thoracotomy, even when the residual air was withdrawn by aspirating needle. The ratio of the frequency of infection between free thoracotomy without aspiration of air, thoracotomy under differential pressure with aspiration of air, and free thoracotomy with aspiration of air was 100 : 83 : 73. Presence of free blood in the pleural cavity and detachment of the pleura do not seem to affect the incidence of infection. (Table 17)

Table 17. Summary of experiments on pleural infection (Effects of residual pneumothorax).

Series number	Free thoracotomy, air not aspirated	Free thoracotomy followed by aspiration of air	Thoracotomy under differential pressure
I	9*	3, 8 } 5.5	9, 10 } 10.5
II	10	8, 9 } 8.5	12
III	10	9, 13, 12 } 11.33	14, 13, 10 } 12.33
Total	29	25.33	34.83
Average per animal	9.66	8.44	11.61
Ratio of average infection per animal	**83**	**71**	**100**

* The figures indicate an approximate degree of infection, with the least macroscopically detectable evidence of infection as a unit.

Table 18. The value of intrathoracic transplantation of the greater omentum with pedicle as a measure of preventing infection (summary of experimental studies).

Number of days after transplantation		1	2	2	2	5	5	7	7	7	7	7	Sum	Average	Ratio
Degree of infection macroscopically estimated, the figure representing an average extent of infection with the smallest infected area as a unit.	Control	2	10	8	11	13	8	13	8	11	12	8	104	9.436	100
	Transplantation group	4	10	8	12	10	6	9	12	14	10	8	103	9.364	99
Average number of colonies from pleural fluid.	Control	8	8	8	1	8	8	1	0	8	8	1.5	58.5	5.318	100
	Transplantation group	8	8	8	1	1	8	1	0.5	8	8	1	53.5	4.863	96
Average quantity of pleural fluid.	Control	2.5	10	8	3		3	18	18			1	63.5	7.937	100
	Transplantation group	1	7	7	3		5	10	10			2	51.25	6.406	81

As prophylaxis against infection we have tried in the rabbit a drainage from the focus in the pleural cavity into the abdominal cavity by means of pediculated omental valve or a segment of trachea, but failed to obtain an anticipated result. (Table 18)

3. The Pleural Immunity.

Used as a prophylactic measure against pleural infection, the bacilus coli or combined streptococcus and staphylococcus koktigen increases phagocytosis in the pleural

Table 19. Summury of experimental studies on the therapeutic activity (phagocytosis) of cooked and uncooked filtrate (antigen) of culture upon pleural infection by staphylococcus aureus.

Variety of antigen injected into the pleural cavity	Quantity of antigen injected	Number of actual phagocytes and of organisms phagocytosed for each 100 polynuclear neutrophyles	Number of eosinophilic leucocytes containing organisms and of organisms phagocytosed by them		Large mononuclears (histeocytes)	
		Number of staphylococci phagocytosed and number of cells phagocytic	%	Number of staphylococci phagocytosed and number of cells phagocytic	%	Number of staphylococci phagocytosed and number of cells phagocytic
Cooked filtrate	3.3	177.0	555.0	166.0	24.5	9.0
Uncooked filtrate	3.0	100.0	572.0	97.0	8.5	3.0
Cooked filtrate	3.3	79.0	540.5	65.0	26.5	14.0
Bouillon	3.5	30.5	570.0	28.5	16.5	2.0
Uncooked filtrate	3.0	138.0	571.0	133.5	14.5	3.5
Bouillon	3.5	94.0	573.5	76.5	14.0	17.5

cavity either by specific or non-specific action. We have employed this agent in our practice routinely. Experimentally we have introduced into the pleural cavity a culture of organisms before or after the intrapleural injection of koktigen of the identical organisms, and tested for intravital phagocytosis, the result showing that prophylactically (injection of koktigen prior to infection) the phagocytosis was 1.8 times and therapeutically (koktigen injection after infection) 2.6 times the control.

Table 20. Summary of experimental studies on prophylactic activity (rate of phagocytosis) of cooked and uncooked filtrate of culture of staphylococcus aureus upon pleural infection by the same organism.

Variety of antigen injected into the pleural cavity	Number of actual phagocytes and of organisms phagocytosed for each 100 polynuclear neutrophyles	Number of eosinophilic leucocytes containing organisms and of organisms phagocytosed by them		Large mononuclears (histeocytes)	
	Number of staphylococci phagocytosed and number of cells phagocytic	%	Number of staphylococci phagocytosed and number of cells phagocytic	%	Number of staphylococci phagocytosed and number of cells phagocytic
Cooked filtrate 3.3 cc.	163.0	549.5	123.0	34.4	38.5
Uncooked filtrate 3.3 cc.	131.5	556.0	104.0	25.0	26.0
Cooked filtrate 3.3 cc.	241.5	547.5	231.0	36.0	10.5
Bouillon	133.0	553.0	124.5	36.0	8.5
Uncooked filtrate	117.0	551.5	95.0	32.5	22.0
Bouillon	86.0	563.0	66.0	21.5	0

Table 21. Immunization of the pleura.

Number of hours after injection	1		3		5		8		15		24		0	
Phagocytosis of the injected side	30.25	336%	41.75	525%	20.5	5010%	33.75	260%	19	158%	33.25	416%	12	150%
Phagocytosis of control side	23.50	261%	28.0	350%	18.0	360%	30.5	235%	17.75	146%	23	288%	11.5	143%
Phagocytosis in normal salt solution	9	100%	8	100%	5	100%	13	100%	12	100%	8	100%	8	100%
Difference between injected and control sides		75		172		150		25		12		128		7

Further experiments in which a piece of costal pleural was resected from one to twenty-four hours after the intrapleural injection of the koktigen, an extract of the resected pleural fragment made, mixed with a culture of corresponding organism, and phagocytosis examined. The result was that the pleural extract which was exposed to the action of koktigen for 24 hours exhibited the most active phagocytosis. (See Tables 19, 20 and 21)

4. Injury to the Pleura.

As a method of repair of pleural defect caused by its injury in an operation upon the oesophagus, we have found experimentally that an excellent plastic result may be obtained by transplanting a piece of subcutaneous fat without pedicle, fascia, or of omentum.

Chapter V. The Diaphragm in Operations upon the Oesophagus.

1. Control of the Movements of the Diaphragm.

By experiments on the rabbits we have established the fact that the active movements of the diaphragm may be stopped for a period of one week by sectioning or crushing the phrenic nerve, and for a period of from one to two hours by blocking it with cocain.

2. Elevation of the Diaphragm.

The extent to which the oesophageal hiatus may be pushed above so as to make the lower part of the oesophagus lie in the abdominal cavity, in other words, the extent to which the oesophagus may be pulled downwards into the abdominal cavity was found by experiments on the rabbits to be up to the mid-point between the pars bifurcalis and the level of the hiatus. In man, it was found to be the lowest ten centimetres.

3. Effects of Establishment of a Direct Communication between the Thoracic and Abdominal Cavities through the Diaphragm.

Entrance of abdominal viscera into the thoracic cavity does not cause danger to life, unless the eviscerated organs become strangulated. That, with an extensive diaphragmatic pseudo-hernia and with a loss of negative pressure in one side of the chest, the life may be maintained if the other lung is healthy was experimentally proved.

Even when the entire width of the diaphragm is left open and there is a wide communication between the thoracic and abdominal cavities, the animal is able to live. When the opening made in the diaphragm is small, the wound may become healed in a short time, the intrathoracic negative pressure become reestablished, the lung expand, and practically all the animals survive. (Table 22) Even clinically, we were able to save 2 out of 4 cases in which the suture of the diaphragmatic wound was inadequate.

Table 22. The effects of artificial diaphagmatic hernia.

Experimental animals		Number of days survived after production of hernia	Right lung	Mediastinum	Left lung
1	♂	Died immediataly	Markedly atelectatic	Practically in midline	Markedly shrunken
2	♂	Killed 15 days later	Old hemorrhagic area in upper lobe	Practically normal	Shrunken but contains air; interlober adhesion slight
3	♂	Killed 15 days later	Normal	Practically normal	Markedly shrunken, parenchymatosis, brown
4	♂	Died a day later	Slightly shrunken	Slightly displaced to left	Markedly shrunken
5	♂	Died in 2 days	Slightly shrunken	Slightly displaced to right	,,
6	♂	Died in 2 days	Slightly shrunken	Slightly displaced to right	,,
7	♂	Killed 19 days	Almost normal	,,	Markedly shrunken; lower lobes parenchymatous, brownish red; sinks in water
8	♂	Died in 2 days	Slightly shrunken	,,	Markedly shrunken
9	♀	Died in a day	Suppurated area	Practically in midline	,,
10	♀	Died in 12 days	Small hemorrhagic area	Markedly displaced to right	Markedly shrunken, parenchymatous
11	♀	Died in a day	Slightly shrunken	,,	Markedly shrunken

Chapter VI. The Relation between the Surgery on the Oesophagus and the Vagus Nerve upon the Respiratory Functions.

Section, ligation, compression, or traction upon the vagus trunk causes irregularity, slowing and deepening of the respiratory movements. There also occur an inspiratory spasms and prolongation of expiratory phases. Deepening and slowing of the respiratory movements persist even after cessation of the mechanical stimuli. That the effects of

these mechanical stimuli are more intense when they are applied on the segment of the nerve above the tracheal bifurcation, than the lower segment, but that cocainization of the nerve trunk previous to the stimulation completely prevents the occurrence of the irritative symptoms have been proved by experiments on the rabbits. (Tables 23, 24, Figs. 24, 25, 26, 27 & 28)

Table 23. Effects of stimulation of the thoracic vagus upon respiration.

Side stimulated	Bilateral	,,	,,	Left side	,,	,,
Mode of stimulation / Time after stimulation	Section (times)	Traction (,,)	Ligature (,,)	Ligature (,,)	Traction (,,)	Section (,,)
Before		10			20	
Immediatly after stimulation		11			21	
3 minutes		10			19	
4 ,,	12	11	16	17	14	12
30 ,,	12	11	14	15	14	10
60 ,,	11	12	12	13	14	10
90 ,,	9	12	12	13	14	9
120 ,,	9	13	13	13	14	9
150 ,,	8	13	14	13	14	11
190 ,,	9	12	14	12	13	10

Table 24. Effects of stimulation of the abdominal vagus nerve upon respiration.

Side stimulated	Bilateral	,,	,,	Left side	,,	,,
Mode of stimulation / Time after stimulation	Traction (times)	Section (,,)	Ligature (,,)	Section (,,)	Ligature (,,	Traction (,,)
Before	7	10	15	11	14	12
Immediately after	7	12	19	13	16	12
3 minutes	7	10	15	11	14	11
10 ,,	7	9	14	9	13	10
30 ,,	7	8	12	7	12	9
60 ,,	7	8	11	7	1	9
90 ,,	7	8	11	7	10	10
120 ,,	8	9	12	8	10	10
150 ,,	9	8	12	9	11	10
190 ,,	9	8	11	9	10	10

1. Effects of Injury to the Vagus Nerve upon the Cardiac Function.

The mechanical stimuli mentioned above applied to the vagus trunk cause a reduction of the blood presure and pulse rate, and these effects are more marked when the

Fig. 24. Bilateral section of abdominal vagus.

Fig. 25. Traction upon the left vagus at the neck.

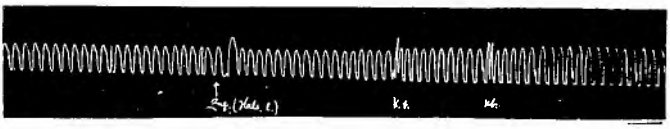


Fig. 26. Compression of right abdominal vagus. (later sectioned)

Fig. 27. Bilateral section of vagus immediately below the origin of the recurrent laryngeal nerve.

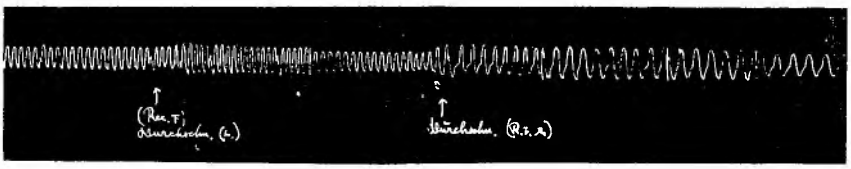
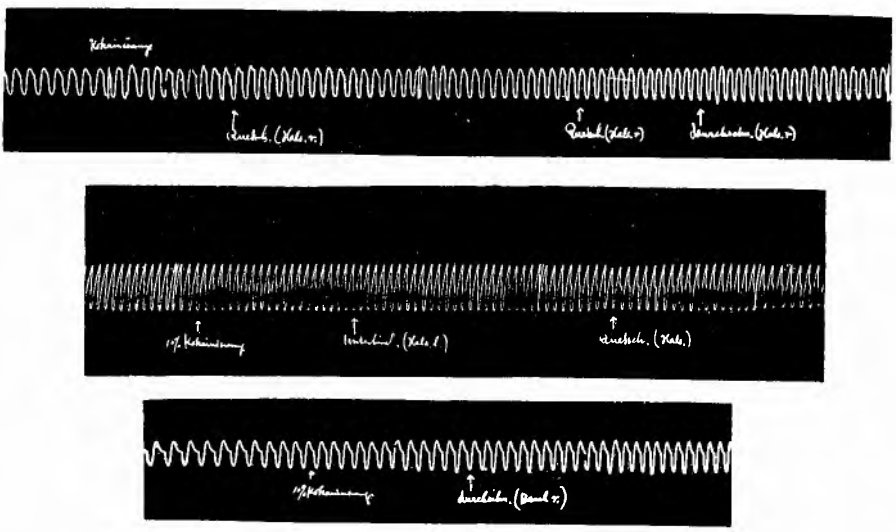


Fig. 28. Compression and section of the vagus after cocainization.



lower segments of the nerve are stimulated. They wear off, however, in a course of 24 hours in most instances.

An electrocardiograph of the above experiments shows that the interval between

Table 25. Alterations of pulse rate produced by injuries to the thoracic vagus.

Animal number		Time after application of injury / Form of injury	Before	Immediately after	3′ after	20′ after	30′ after	60′ after	90′ after	120′ after	150′ after	180′ after
74	Bilateral	Ligation				56	56	56	55	53	53	52
73	,,	Section				48	49	50	50	48	46	46
83	,,	Traction	41	43	44	47	44	45	44	44	43	42
79	Unilateral	Ligation				49	49	49	46	46	44	42
82	,,	Traction	52	52	53	53	53	51	49	46	45	44
84	,,	Section				53	52	51	49	48	46	47

Fig. 29. Changes produced on the blood pressure curve by injuries to the thoracic vagus.

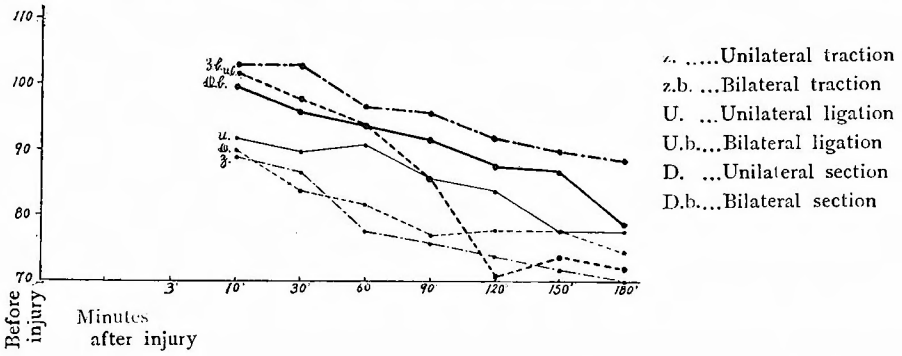
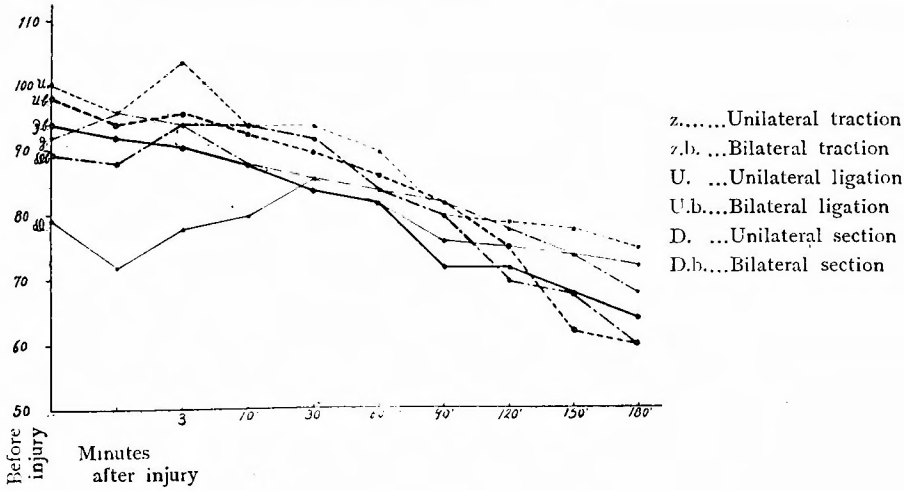


Fig. 30. Changes produced on the blood pressure curve by injuries to the abdominal vagus.



successive waves is prolonged, but that there is no particular difference produced by stimulation of different segments of the nerve. (Table 25, Figs. 29, 30, 31, 32, 33)

Fig. 31. Kymographic record of alterations of the heart beat by compression of the right thoracic vagus.

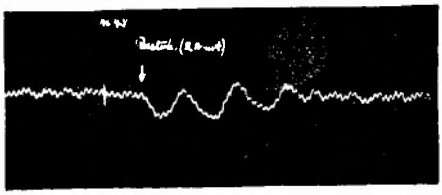


Fig. 32. Alteration of the heart beat caused by traction applied to the abdominal vagus.

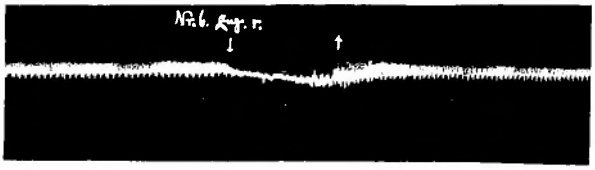
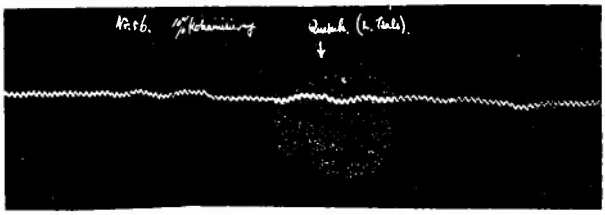


Fig. 33. Blood pressure after compression of the vagus after cocainization.



Chapter VII. The Relation between the Stomach and the Operations upon the Oesophagus.

1. *Quantitative Estimation of the Nutrition of the Gastric Wall.*

In operations upon the oesophagus the significance of the stomach is almost equal in importance to that of the oesophagus itself. By the method identical with that used in estimating the nutritional conditions of the oesophagus, we have studied the relative nutritional state of different parts of the stomach. The results have shown that the cardiac region and the lesser curvature are most richly supplied with arterial blood, being approximately twice the volume supplied to the body of the stomach, and that there is no appreciable difference between the anterior and posterior walls.

The blood flowing to the abdominal part of the oesophagus is approximately 1.7 times that supplied to the stomach, and that supplied to the proximal part of the duodenum is practically equal to that of the gastric wall. (Table 26)

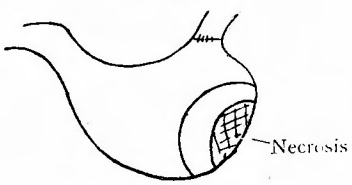
Table 26. Quantitative studies on the nutrition of the stomach.

	Average value obtained by Exp. 1–4	Average value obtained by Exp. 5–7	General average
Anterior wall of the pyloric region	2.2	2.6	2.4
Anterior wall of the cardiac region	4.2	4.2	4.2
Anterior wall of the body of stomach	3.1	2.2	2.7
Anterior wall of the fundus	2.2	3.8	2.9
Posterior wall of the pyloric region	2.4	2.8	2.5
Posterior wall of the cardiac region	4.2	6.3	5.1
Posterior wall of the body of stomach	2.1	2.0	2.0
Posterior wall of the fundus	3.1	3.1	3.1
Anterior wall	2.4	2.6	2.5
Posterior wall	2.7	2.6	2.6
Pyloric region	2.3	2.7	2.5
Cardiac region	4.2	5.3	4.8
Body of the stomach	2.6	2.1	2.4
Fundus	2.7	3.5	3.1
Stomach	2.5	2.6	2.6
Oesophagus	3.0	4.0	3.5

2. *Blood Circulatory Disturbance of the Stomach Produced by Its Mobilization.*

Mobilization of the stomach is a procedure absolutely necessary for performance of oesophago-gastrostomy after resection of the lower part of the oesophagus and the cardia. In order to evaluate the extent of the blood circulatory impairment of the stomach caused by its mobilization, a series of experiments were conducted. The results have shown that when the two arteries in the oral part of the stomach are ligated, the stomach isolated, an anastomosis between the intestine and the part of the stomach supplied by the ligated vessels made, there is no appreciable nutritional disturbance, and the anastomosis heals nicely. If, in addition to these procedures, the circulation to the stomach from above is cut off by division of the oesophagus there is produced a marked circulatory impairment of the fundus of the stomach. (Fig. 34)

Fig. 34.



Chapter VIII. Role of the Jejunum and Colon in Operations Upon the Oesophagus.

Our experiences in operations on clinical cases show that the extent to which the jejunum may be mobilized upward is the level of the mamma, and an attempt at a farther mobilization causes a circulatory failure to the moblized segment. The ascending and the transverse colon may be isolated and mobilized with the middle colic artery kept intact, without producing any circulatory disturbance.

By the various experimental studies briefly described above, we believe that, the many problems connected with thoracotomy, which is essential to the oesophageal surgery, have been solved, and the foundation upon which the oesophagus may be attacked surgically established. And, it is noteworthy that the different experimental studies performed by different men have uniformly shown the superiority of free thoracotomy over that under differential pressure.

Section II. Clinical Considerations of the Surgery of the Oesophagus.

Chapter I. Diagnostic Methods of the Diseases of the Oesophagus.

In this chapter, instead of discussing individually the usual diagnostic methods of numerous diseases of the oesophagus, we shall confine ourselves to the consideration of a few diagnostic methods. The number of cases of diseases of the oesophagus that came to our clinic since 1925 total 213, these being classified in the accompanying table. (Table 27.)

Of acute inflammatory diseases, injuries, swallowed foreign bodies, and cicatricial stricture, whose causes are known, diagnosis is rarely difficult. In diseases of chronic nature, on the other hand, it is generally not easy to make an early diagnosis, and by the time the disease is suspected from the patient's complaint, the process has usually progressed considerably. Such is the state of affairs frequently met with in carcinoma of the oesophagus. A close scrutiny of the history will show, however, that a disturbance in passage of bolus or a symptom referred to the stomach antedated the onset of the presenting symptom, or that the symptoms due to a long standing organic disease was considered improved by treatment directed at presumably a functional one. Such a state of affairs owes its existence to the fact that a practice of systematic disgnostic studies is not generally carried out.

The major part of the oesophagus is naturally not subject to palpation, but a presence of a tumor in the cardiac part may be occasionally recognized by a deep palpation immediately below the xyphoid process as a resistance or a mass during deep inspiration.

Table 27. Classification of the oesophageal cases according to diagnosis (Series between September 1925 and February, 1932).

Functional diseases	
Spasm of the oesophagus	1
Atonia of the oesophagus	2
Paralysis of deglutition	2
Idiopathic dilatation (cardiac spasm)	9
Organic diseases	
Deformity	0
Diverticula	2
Oesophagitis	5
Specific inflammation (tuberculosis, syphilis)	0
Stricture from scar contraction	7
Injuries	2
Neoplasms	
Benign myoma	1
Tumors at the pharynx	7
Carcinoma of the thoracic part	72
Carcinoma of the lower part and the cardia	68
Miscellaneous	
Oesophago-bronchial fistula	2
Entrance of barium meal into the trachea	2
Foreign body in the oesophagus	20
Stenosis of the oesophagus by pressure from the diseases of neighboring structures	7
Elongatio oesophagi	4

1. X-ray Examination.

Röntgenology stands at the head of diagnostic methods in the diseases of the oesophagus and should never be omitted. We have found that an exposure at a high pelvic posture is a method which should be added to the usual upright, first and second oblique postures. The high pelvic posture is especially effective in revealing the width, extent, and the lower boundary of a tumor; and in the cardiac tumors, its superiority is particularly emphatic in that the induration by the tumor is clearly brought out. (Fig. 35, 36, 37 & 38.)

Of great value as an adjunct to x-ray examination of the oesophagus is the pharmaco-dynamic test as a means of differentiating the functional from the organic disease.

The pilocarpin test works selectively upon essentially spastic disease such as idiopathic oesophageal dilatation by stimulating the vagus nerve, and by its use the lower part

Fig. 35. Patient, J. F. aged 43 years male.
The lower border of the tumor visualized by high pelvic posture.

Fig. 36. The same case.
The lower border of the tumor not visualized by upright posture.

Fig. 37. Röntgenogram of the case of carcinoma of the cardiac portion. Standing posture.
By this posture, the tumor is not visualizable, although an irregular out-line of filling defect is noted.
The patient, S. H., male, aged 61 years.

Fig. 38. High pelvic exposure. Correponding to the tumor there is a filling defect around the cardia.
The same case as Fig. 37.

Fig. 39. Combined Pharmacodynamic and röntgenologic method as a means of differentiation between functional and organic diseases of the oesophagus.
Patient. Y. T. aged 44, male.

Fig. 40. The same case as above. By an injection of 1 cc. of 1% pilocarpin solution, the lower limit of the oesophagus is elevated and the waves of spasm have appeared.

Fig. 41. Pharmacodynamic Röntgenology, ii
Papaverin-adrenalin test.
Patient. M. Y., aged 37, male.
Röntgenogram before injection.

Fig. 42. The same case.
A hypodermic injection of 1 cc. of 1/1000 adrenalin solution was given 20 minutes after an injection of 1 cc. of 5% papaverin hydrochloride solution. 20 minutes after adrenalin injection, the lower border of the oesophagus descends and expands like pseudopodia of an amoeba, its content clearly being emptied into the stomach.

of the oesophageal shadow becomes narrowed, its lower end becomes elevated, the oesophageal content stagnates, and the spastic waves due to hyperperistalsis make their appearance. (Fig. 39, 40.)

By papaverin-adrenalin test, the sympathetic nerves are stimulated. If the spasm is previously relieved by administration of papaverin, a subsequent adrenalin injection is followed in from a few to 20 minutes by a downward prolongation of the lower end of the oesophageal shadow and a rapid expulsion of the oesophageal content into the stomach, in a purely functional disease. In an organic disease, on the other hand, no such changes follow the application of the test. The principles and practical working of these test agree with the facts revealed in our physiological studies. (Fig. 41, 42, Table 28.)

Table 28. The results of pharmacodynamic test with rõntgenology.

Name of Patient	Diagnosis	Adrenalin test	Atropin test	Pilocarpin test
Nagamura 44 ♂	Idiopathic dilatation of the oesophagus	++++		
Yamakami 34 ♂	,,	++		++
Sakaguchi 27 ♂	,,	++		++
Yoshida 52 ♂	Cardiospasm	++		
Tomizawa 44 ♂	Idiopathic dilatation of the oesophagus	−	−	++
Sato 26 ♂	Oesophagospasm			++++
Kurosawa 14 ♂	Oesophagitis			−
Yuasa 37 ♂	,,			−
Takemoto 52 ♂	Carcinoma of the cardia	−		−
Shiraki 31 ♂	Oesophagitis	−		−

The method in which the oesophagus is filled with gas is obviously not applicable to the cases of stenosis.

Production of pneumoperitoneum merely intensifies the outline of the shadow and it does not yield a finding other than that obtained by the methods described above. The condition of induration by the tumor at the lower part of the oesophagus, the cardia, and the upper part of the stomach is clearly brought out by application of high pelvic posture, without the presence of pneumoperitoneum.

2. *Oesophagoscopy.*

It is needless to say that the endoscopic examination of the oesophagus is of paramount importance in recognizing the diseases of the mucosa and the foreign body that is not opaque to x-rays. It is an indispensable method especially in early diagnosis of carcinoma of the gullet. It is our custom to oesophagoscope all the

cases in which the diagnosis remains undefined by the x-rays, and to date we have been able to establish the diagnosis of chronic oesophagitis, oesophageal fistula, idiopathic oesophageal dilatation, benign papilloma, the sensory nervous disturbance of the gullet, and foreign bodies.

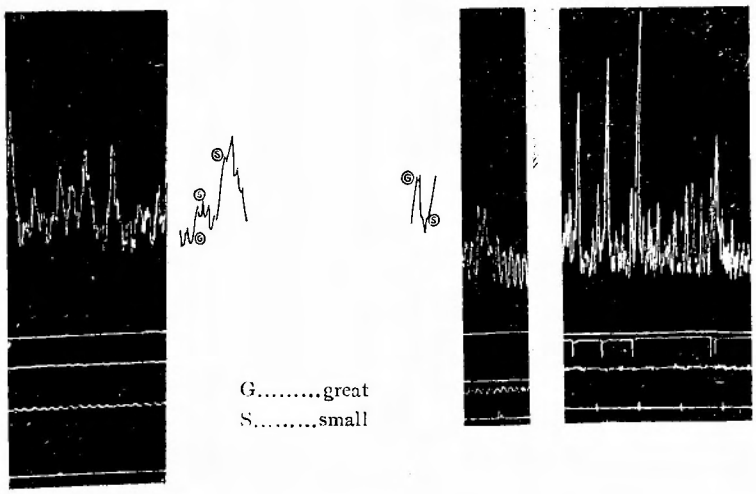
3. Kymographic Study of the Movements of the Oesophagus.

This is a method by which a minute observation of the oesophageal motility may be made, and there has been an attempt to utilize it clinically. Although the results of our studies fail to confirm the claim made by some writers that carcinoma produces a characteristic curve, yet by studying the kymographic record it is possible to determine the presence or absence of abnormal adhesion. Thus, it is found that whereas under normal conditions, the amplitude of the pulse waves in the inspiratory phase (corresponding to the stage of dilatation of the oesophagus) is smaller than or equal to that in the expiratory phase (the stage of contraction of the oesophagus), in the presence

Fig. 43.

U. O. ♂
Idiopathic dilatation of the oesophagus.
Positive result.

H. K.
Carcinoma of the cardia.
Negative result.



of adhesion between the oesophageal wall and adjacent viscera, it becomes greater on the ascending respiratory curve (expiratory phase corresponding to the stage of contraction of the oesophagus). When the latter form appears on the kymographic record, we consider that there is an abnormal adhesion. This method, therefore, is considered as a valuable accessory in the study of the oesophagus, although it is not acceptable as an independent procedure. (Fig. 43)

Section III. The Surgical Operations on the Oesophagus.

Chapter I. The Methods of Approach.

1. The Cervical Oesophagus.

The cervical part may be approached by routes described in the surgical textbooks.

2. The Thoracic Part of the Oesophagus.

In approaching the thoracic part of the oesophagus, we have entirely discarded the use of differential pressure apparatus, since, as we have already stated, our various experimental studies have proved that the free thoracotomy is the most logical method. The operative procedures furthermore are more easily and safely carried out under the

Table 29. Classification of methods of approach to the thoracic oesophagus that have been employed in our clinics.

Free Thoracotomy	20
Free thoracolaparotomy or free laparothoracotomy	17
Free trensdiaphragmatic thoracolaparotomy	19
Posterior mediastinal approach	7
Anterior mediastinal approach	2
Transdiaphragmatic thoracotomy	1
Transdiaphragmatic extrapleural approach	1
Fxtrapleural-abdominal approach	1
Total	68

Classification of diseases of the thoracic oesophagus operated upon in our clinics.

Carcinoma of the thoracic part and of the cardiac part of the oesophagus	49
Carcinoma of the upper segment of the stomach	3
Myoma	1
Idiopatic dilatation	7
Foreign body	1
Spastic disease	1
Oesophagitis	〃
Elongatio oesophagi	〃
Sarcoma of the mediastinum	2
Total	68

normal atmospheric pressure. Under differential pressure it is entirely impossible to carry out surgical manouvers upon the oesophagus. This is the very factor that hindered the progress of this line of surgery.

A series of 68 cases of diseases of the thoracic part of the oesophagus were subjected to free thoracotomy, and in none of these cases have we encountered dangers directly referrable to the operation itself. (Table 29.)

The thoracic oesophagus may be approached, either by opening the mediastinum from the front or behind, transpleurally from the lateral thoracic wall, or by collo-abdominal method.

The best practical approach, however, is that of opening the mediastinum from behind and lateral transpleural route under the normal atmospheric pressure, since by these routes a sufficient operative field is obtainable. The anterior mediastinal approach affords only a narrow space in which to work and the subsequent closure of the wound is unsatisfactory.

Although collo-abdominal method or its modification, the method of invagination, is applicable also to the cardiac part of the oesophagus, yet by this method, dissection of the oesophagus must be done blindly, and for this reason it cannot be commended, and there has not been a case reported alive with this technique.

3. The Lower Part of the Oesophagus, and Cardia.

This segment constitutes a boundary between the thorax and abdomen, and for this reason whichever route of approach, thoracic or abdominal, is chosen, the operative procedure cannot frequently be completed without encroaching upon the other, that is even if transabdominal route is chosen, the thoracic cavity will likely have to be entered through the diaphragm during some stage of the operation. Since the possibility of removal of carcinoma from this region depends primarily upon the conditions of the stomach and upon whether it may be mobilized or not, it is best first to determine this point by a preliminary laparatomy. For such purely intrathoracic operation as oesophagoplasty (with isolation of the oesophagus at the hiatus), on the other hand, the thoracotomy should be done from the start.

An approach to this part may be accomplished through the abdominal cavity, the thoracic cavity, or by way of the transabdominal-extrapleural route.

In the usual transabdominal technique, it has been the universal attitude of surgeous to fear and methodically avoid an injury to the pleura, the invariable result being the restricted operative field. It is our principle not to worry about pleural injury. Our transabdominal technique, in which the thoracic cavity is frequently entered whenever it becomes necessary, must be considered in reality as a semithoracotomy. It is practically an abdominal substitute for free thoracotomy. A skin incision, is made as shown in the figure 44, about 3 cm. of 7th, 8th, and 9th ribs or their cartilages on the left side are resected, the 9th intercostal space is incised for a length of 5 cm., the costosternal border of the seventh rib divided, and thus the left costal arch is destroyed.

Fig. 44. Semithoracotomic laparotomy (Transabdominal semithoracotomy).

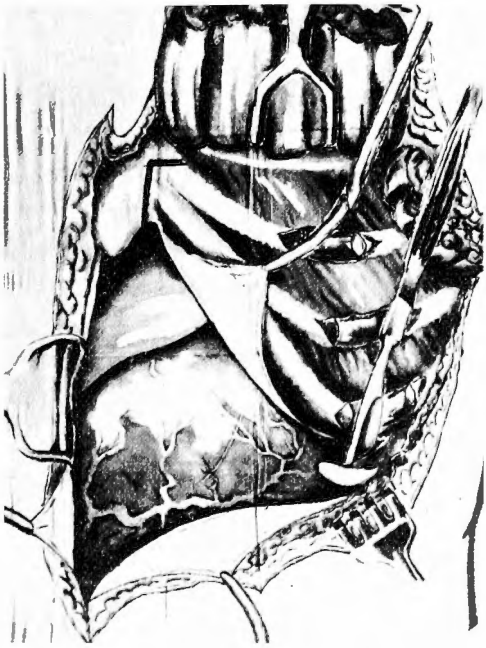


Fig. 45. Semithoracotomic laparotomy.

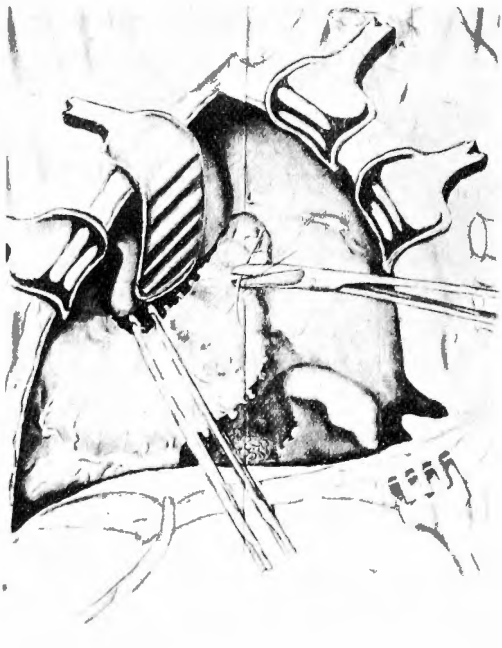


Fig. 46. Transabdominal semithoracotomy.

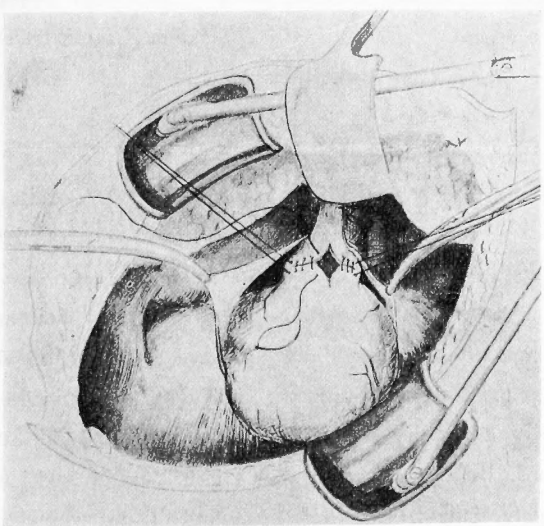
Fig. 47. Transabdominal semithoracotomy.

The costal flap is then retracted upward. If the pleura is injured during this manouver, no attention is paid to it. The triangular ligament is then cut off, the left lobe of the liver is made free and retracted toward right, the peritoneum covering the oesophageal hiatus is cut through circularly, the oesophagus exposed, and the conditions of this segment of the gullet are inspected. By this method, we have been able to expose about 10 cm. of the lower part of the oesophagus in most of our cases. This is quite an advantage over the usual technique in which, the operations such as extirpation of tumor can be performed only on about 5 cm. of the oesophagus. (Fig. 44, 45, 46 & 47.)

A graphic demonstration of extirpation of carcinoma of the cardia by this technique was presented by cinematograph at Japan Surgical Society on April 3, 1932.

Depending upon the conditions of the tumor and the presence of adhesions, however, this form of operation may be insufficient and it may become necessary to open the thorax. The simplest way to accomplish this would be either to incise the diaphragm from the abdominal side and enter the thoracic cavity or to detach the diaphragm, approach the thorax extrapleurally and enter the thoracic cavity. We have tried this last method on two cases, and found it inconvenient for procedures upon the oesophagus. The usual extrapleural-transabdominal method was tried once in our hands, and it appears to us to involve too great a surgical intervention for the purpose. The last method had been divided into two stages, and we have also applied it on two cases, but after the preliminary operation, the patient was so exhausted that fatality occurred before the final operation could be done in both cases. Considering the ease of technical procedure and the degree of surgical interference, we believe that in those cases of diseases of the lower portion of the oesophagus and cardia which require thoracotomy, free transdiaphragmatic thoracolaparotomy is the method of choice. For somewhat more complicated cases, free thoracolaparotomy or laparothoracotomy is the most acceptable technic in our opinion. These methods have been insisted upon by us for several years. The transdiaphragmatic-thoracolaparotomy consists of entering

Fig. 48. Oesaphagoplasty under free transdraphragmatic thoraco-laparotomy.



the thoracic cavity by a lateral thoracic incision and incision of the diaphragm from the thoracic side. The latter consists of incision of the diaphragm after dividing the costal arch, and intercostal incision on the lateral thoracic wall, followed by laparotomy and is performed as described below.

Free transdiaphragmatic thoraco-laparotomy. (Fig. 48.)

A hook-formed incision is made on the thoracic wall, starting at the junction of the anterior axillary line and the seventh rib, passing the level of the tenth rib on the posterior axillary line, and terminating on the paravertebral line at the level of the sixth rib. The skin-muscle flap is turned upward, and the thorax is entered in the seventh intercostal space after resecting segments about 15 cm. long of the seventh and eighth ribs. Upon entering the thoracic cavity, the phrenic nerve is identified and either crushed or sectioned. When the diaphragm becomes quiescent by this manouver, the mediastinal pleura is incised along and in front of the aorta for a length of approximately 6 cm., and the oesophagus is exposed to view. The lower, exposed portion of the oesophagus is isolated from the surroundings, and after carefully reviewing its anatomical conditions, the incision of the mediastinal pleura is extended downward. The oesophageal hiatus is next incised, the membranous part of the diaphragm is then incised obliquely toward the left, and thus the thoracic and abdominal cavities are made to communicate with each other directly, and the lower part of the oesophagus and the cardia are brought into a single operative field.

After having carried out the operative procedures required by the nature of the case, the diaphragm is sutured to the oesophagus as far above the part which was involved in the operation as possible, so that this part of the oesophagus would lie within the abdominal cavity. The mediastinal pleura is then sutured, the costal pleura is also sutured, the muscular flap is replaced and sutured. An aspirating needle is now introduced and the air remaining in the pleural cavity is withdrawn, after which the skin incision is closed.

Free Thoraco-laparotomy (free laparo-thorocotomy).

Laparotomy may precede thoracotomy (free laparo-thoracotomy) or it may follow the latter (free thoroco-laparotomy). Which should be the beginning part of the operation depends entirely upon the necessity of each case. (Fig. 49.)

In case the laparotomy is to be done first, either a midline or left pararectal incision is made from the seventh costal cartilage to somewhat above the navel ; the peritoneal cavity is opened and the conditions of the viscera examined ; and then the skin incision is extended upward and laterally along the chest wall so that it forms an arc with the left eighth rib as its chord, the posterior superior limit of the incision corresponding to the height of the inferior angle of the left scapula. Then segments

approximately 1.5 cm. long of the seventh and eighth ribs are resected. (At times only the 8th rib is resected, and occasionally no rib resection is neccssary).

The pleura is incised in the seventh intercostal space, and the intrathoracic conditions are reviewed. Next the costal arch in the seventh intercostal space is cut through. The diaphragm is now divided from this point to the oesophageal hiatus, thus converting the abdominal and thoracic cavities into a single field of operation.

After the necessary operative

Fig. 49. Free thoracolaparotomy (left side)

a

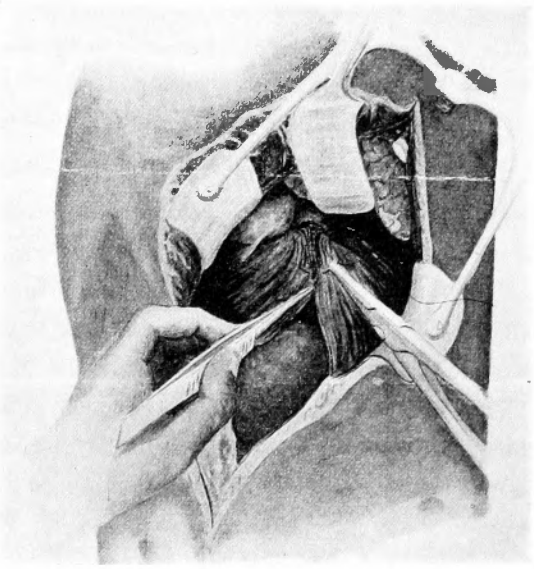
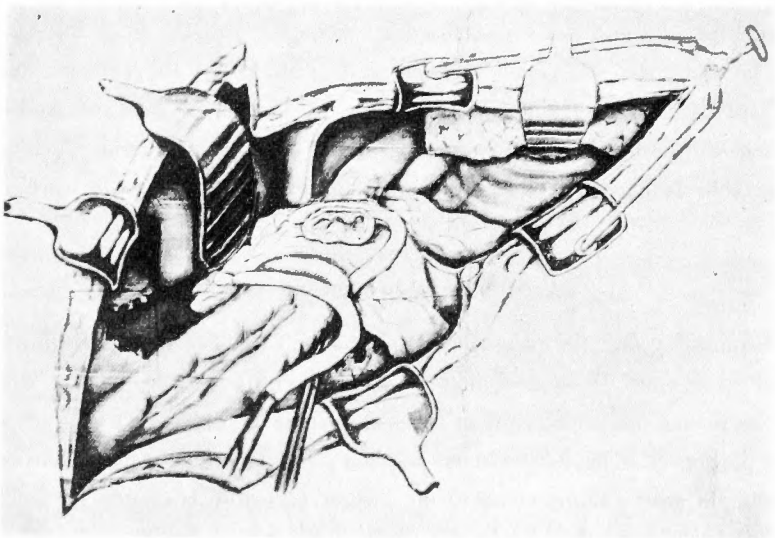


Fig. 49 b



manouvers are performed, the thorax is closed as previously described, using silk thread for suturing the divided costal arch. In case the thorax is opened first, the steps in the operation are merely reverse of the above description.

With a midline abdominal incision, the starting point should be the upper third of the

linea alba between the xyphoid process and navel, and an additional skin incision is made in the seventh intercostal space, as in Kirschner's Angelhakenschnitt.*

Chapter II. Resection and Suture of the Oesophagus.

1. *The Suture Technic. An End-to-End Anastomosis.*

That, in the repair of both the stump after resection and incisional wound of the oesophagus, suturing of the individual layers separately is superior to the whole thickness suture, was uniformly demonstrated by experimental work done independently by three different workers. Oka's experiments, for instance, have shown that while 9 out of 15 animals in which the layer suture was done healed completely, there were only 2 out of 10 cases in which healing took place after the whole thickness suture.

The technique of layer suture was employed by us not only in closing the gastric stump in resection of the stomach, but in gastroenterostomy also, and was found to be far superior to the whole thickness suture, and in dealing with the oesophagus the superiority was found especially well-marked.

The factors that distinguish the suture of the oesophagus from the gastro-intestinal tract are 1) the oesophagus easily suffers from circulatory disturbance, 2) the oesophagus does not possess serora, and 3) tension is borne by the anatomosis. Unless these factors are kept in mind, success cannot be expected. Judging from this standpoint, the parts in which an end-to-end anatomosis is feasible are the cervical, the upper thoracic, and those regions which lie outside of the regions of least resistance. And according to the results of our experiments on the dog, the maximum extent of resection compatible with healing of anastomosis is limited to 4 cm. in the upper thoracic part.

2. *The Oesophago-gastrostomy.*

In anastomosing the oesophagus to the stomach or intestine, the three factors mentioned above must be kept in mind. And, since the fundus of the stomach is liable to circulatory impairment when the oesophagus is divided, as the experiments described previously show, it should be resected ; and in order to avoid tension at the anastomosis, the gastric stump closer to the greater curvature is chosen for anastomosis, this practice being considered to be the reason for our success.

The various technical methods of the oesophago-gastrostomy that are fonnd in the literature, such as three layer and two layer suture, and anastomosis by means of

---

* When this tehhnic is employed on the right side, it will become a method by which the upper surface of the right lobe of the liver is exposed.

Murphy botton, have been repeated by us, and all of them found inadequate. Although the methods devised by Witzel, Kader, and Sauerbruch (Enstülpungsresektion) are superior to these in regard to healing, yet they require a considerable space in which to work, the actual procedure is difficult of performance and the post-operative stenosis is unavoidable. Of the three, Kader's method possesses least of these evils. (Table 30.)

At a first glance, Sauerbruch's method of Einstülpungsresektion appears to be an excellent technic in respect to healing of the anastomosis, but in reality it is not. It is extremely uncertain of resection which is the prime object of the operation. Necrosis of the segment lying between two lines of compression or crushing would not be absolutely certain to follow even if the viscus involved were thin-walled like the intestine, if mesentery were intact. With the stomach, and even more so with the oesophagus, a sufficiently forceful compression will cause a performation with the resultant contamination, and with a compression not enough forceful will not bring about a desired circulatory disturbance. According to the results of our experimental work, the actual cutting is the only dependable method of resection. Curiously, Sauerbruch's method is not reliable even in regard to asepsis which is supposedly one of its chief chracteristics. Repeated experimental studies have shown that the operation by this method is frequently followed by infection. Again, in those cases in which this method is applicable, a resection followed by an end-to-end anastomosis can be easily and aseptically performed, making Sauerbruch's technique absolutely unnecessary.

The most dependable method of anastomosis was found, as it is shown on table 31 of our experimental series, to be that in which the layer suture is applied and the site of anastomosis is methodically covered by the great omentum. In this method, the site of anastomosis is practically enclosed by an artificial omental hernia, which converts this part of the thorax into an extension of the abdominal cavity, and an attempt is thus made to prevent pleural and mediastinal infection, as well as adhesion to the left lung and the pericardium. Experimentally the method was proved to be an ideal one, and clinically its application was followed by excellent results. In our series of 19 clinical cases, in which this technic was employed in performance of oesophago-gastrostomy, in 5 of which the operation was done in the thoracic cavity, a cure was obtained in 9 cases. (Table 32.)

3. The Oesophago-jejunostomy.

In spite of the fact that the results of our experimental oesophago-jejunostomy in the thoracic cavity were bad, we were able to cure two patients in whom the operation was performed. (Table 33.) Where the jejunum is to be utilized for anastomosis, we prefer to apply an end-to-side technic as far as possible, but if tension is unavoid-

Table 30. Smmary of experiments

Experiment number	Dog number	Sex	Body weight	Technic of anastomosis and suture	Result	Condition of the anastomosis
1	6	♂	15	Oesophagogastrostomy; 3 layer suture	died in 4 days	Perforated
2	7	♂	8	,,	,, ,, 6 ,,	,,
3	8	♀	8	,,	,, ,, 7 ,,	,,
4	9	♂	7	,,	,, ,, 23 ,,	Completely healed
5	62	♂	4	,,	,, ,, 3 ,,	Perforated
6	10	♂	10	Oesophagogastrostomy; 2 layer suture	,, ,, 5 ,,	Perforated
7	11	♂	5	,,	,, on table	Not perforated
8	12	♂	8	,,	,, in 2 days	Not perforated
9	13	♂	17	,,	,, on table	
10	14	♂	10	,,	,, in 78 days	Completely healed
11	15	♂	10	,,	,, ,, 4 ,,	Perforated
12	16	♂	6	Thchnic similar to Witzel's gastrostomy	,, ,, 20 ,,	Completely healed
13	18	♂	7	,,	,, ,, 5 ,,	Almost completely healed
14	19	♀	5	,,	,, ,, 3 ,,	Not perforated
15	20	♂	18	,,	,, ,, 5 ,,	Some stitches came out but not perforated
16	21	♂	7	Anastomosis with Murphy's button; Lemhert's suture	,, ,, 5 ,,	Perforated
17	22	♂	6	,,	,, on the night after operation	Not perforated
18	23	♂	6	,,	,, in 3 days	Perforated
19	24	♂	6	,,	,, on table	
20	29	♂	8	Einstülpungsresektion (intragastric invagination)	,, in 3 days	Not perforated
21	32	♂	16	,,	,, ,, 4 ,,	Almost completely healed
22	36	♀	11	,,	,, ,, 5 ,,	,,
23	37	♀	15	,,	,, ,, 2 ,,	Not perforated
24	74	♂	5	Oesophago-oesophagostomy; 3 layer suture	,, ,, 3 ,,	Perforated
25	75	♂	6	Oesophago-oesophagostomy; 2 layer suture	,, ,, 11 ,,	Completely healed
26	76	♀	16	,,	,, ,, 29 ,,	,,
27	77	♀	16	,,	,, ,, 3 ,,	Perforated
28	58	♀	6	Oesophago-gastro-gastrostomy	,, ,, 3 ,,	Not perforated
29	61	♀	5	,,	,, ,, 2 ,,	,,
30	63	♀	10	,,	,, ,, 3 ,,	Perforated
31	64	♂	8	,,	,, ,, 3 ,,	Perforated
32	60	♂	16	Technic similar to Kader's gastrostomy	,, ,, 2 ,,	Not perforated
33	80	♂	4	,,	,, ,, 4 ,,	Almost completely healed
34	81	♂	4	,,	,, ,, 2 ,,	Not perforated
35	86	♂	6	,,	,, ,, 19 ,,	Completely healed

on oesophago-gastrostomy.

Cause of death	Extent of resection	Postoperative vomiting		Stenosis at autopsy
		milk	cooked rice	
Empyema thoracis due to perforation	Lowest 6 cm. of oesophagus + part below cardia	+		No marked stenosis
,,	Lowest 8 cm. of oesophagus + a part below cardia	−		,,
,,	Lowest 3 cm. of oesophagus + upper half of stomach	−		,,
Emaciation	Lowest 10 cm. of oesophagus + upper half of stomach	−	+	,,
Empyema thoracis due to perforation	Lowest 5 cm. of oesophagus + cardiac part	Not determined		,,
Empyema thoracis due to perforation	Lowest 8 cm. of oesophagus + upper half of stomach	+		No marked stenosis
Accidental ligation of vagus?	Lowest 8 cm. of oesophagus + upper 3 cm. of stomach	Not determined		,,
Not determined	Lowest 6 cm. of oesophagus + upper 1/4 of stomach	,,		,,
Accidental ligation of vagus?	Lowest 5 cm. of oesophagus + upper 1/3 of stomach	,,		,,
Emaciation	Lowest 5 cm. of oesophagus + upper 1/3 of stomach	−	−	,,
Empyema thoracis due to perforation	Lowest 8 cm. of oesophagus + upper 1/3 of stomach	−		,,
Emaciation	Lowest 5 cm. of oesophagus + upper 1/5 of stomach	+	+	Marked stenosis
Empyema thoracis	Lowest 6 cm. of oesophagus + upper 1/5 of stomach	+		No marked stenosis
Not determined	,,	Not determined		,,
Empyema thoracis	Lowest 5 cm. of oesophagus + upper 1/5 of stomach	+		,,
Empyema thoracis due to perforation	Lowest 6 cm. of oesophagus + upper 1/4 of stomach	+		No marked stenosis
Not determined	Lowest 8 cm. of oesophagus + upper 1/3 of stomach	Not determined		,,
Empyema thoracis due to perforation	Lowest 6 cm. of oesophagus + upper 1/4 of stomach	−		,,
Acute atonia of stomach	Lowest 6 cm. of oesophagus + upper 1/5 of stomach			
Not determined	Lowest 5 cm. of oesophagus + upper 1/3 of stomach	Not determined		Marked stenosis
Empyema thoracis	Lowest 2 cm. of oesophagus + upper 1/4 of stomach	+		No marked stenosis
,,	Lowest 3 cm. of oesophagus + upper 1/5 of stomach	Not determined		,,
,,	Lowest 6 cm. of oesophagus + upper 1/3 of stomach	,,		,,
Empyema thoracis due to perforation	From 5 cm. to 1.5 cm. above cardia	+		Stumps detached
False diaphragmatic hernia, acute dilatation of stomach	From 3 cm. to 1 cm. above cardia	−		No marked stenosis
Emaciation	From 3 cm. to 2.5 cm. above cardia	−	−	,,
Mediastinitis due to perforation	From 5 cm. to 2.5 cm. above cardia	Not determined	+	,,
Empyema thoracis	1/3 of corpus ventriculi and a part of oesophageal wall	−		No marked stenosis
Peritonitis	1/4 of corpus ventriculi and a part of oesophageal wall	Not determined		,,
Intraabdominal hemorrhage + rupture of anastomosis	,,	,,		,,
Peritonitis due to perforation	,,	−		,,
Morphine intoxication	Lowest 6 cm. of oesophagus + upper 1/4 of stomach	Not determined		Marked stenosis
Not determined	Lowest 6 cm. of oesophagus + upper 1/5 of stomach	+		No marked stenosis
,,	Lowest 5 cm. of oesophagus + upper 1/5 of stomach	Not determined	+	,,
Emaciation	,,	−		,,

Table 31. Results of experimental studies

Experiment number	Dog number	Sex	Body weight	Operative procedures	Extent of resection
1	25	♂	6	2 layer suture covered with omental hood	Lowest 5 cm. of oesophagus + upper 1/5 of stomach
2	26	♂	6	,,	5 ,, ,,
3	27	♂	18	,,	7 ,, ,,
4	28	♀	12	,,	Lowest 7 cm. of oesophagus + upper 1/4 of stomach
5	68	♂	10	3 layer suture covered with omental hood	Lowest 4 cm. of oesophagus + upper 1/4 of stomach
6	36	♀	16	Anastomosis with Musphy's button covered with omental hood	Lowest 6 cm. of oesophagus + upper 1/4 of stomach
7	42	♂	9	2 layer suture covered with omental hood	Lowest 6 cm. of oesophagus + upper 1/4 of stomach
8	34	♀	8	2 layer sture + displacement of the site of anastomosis into abdominal cavity	Lowest 4 cm. of oesophagus + upper 1/3 of stomach
9	35	♂	8	,,	Lowest 4 cm. of oesophagus + upper 1/3 of stomach
10	38	♂	9	,,	Lowest 5 cm. of oesophagus + upper 1/3 of stomach
11	30	♀	10	,,	Lowest 6 cm. of oesophagus + upper 1/4 of stomach
12	70	♀	5	3 layer suture + displacement of the site of anastomosis into abdominal cavity	Lowest 4 cm. of oesophagus + upper 1/5 of stomach
13	56	♀	8	3 layer suture (anastomosis between stomach and abdominal part of oesophagus)	From immediately above cardia to middle of stomach
14	57	♀	8	,, (,,)	,,
15	69	♂	6	,, (,,)	From immediately above cardia to upper 1/5 of stomach
16	73	♂	6	2 ,, ,, (,,)	From immediately above cardia to upper 1/4 of stomach
17	5	♂	5	3 layer suture + false diaphragmatic hernia	Lowest 5 cm. of oesophagus + upper 1/5 of stomach
18	12	♀	12	,,	Lowest 6 cm. of oesophagus + upper 1/5 of stomach
19	6	♀	6	,,	Lowest 5 cm. of oesophagus + upper 1/4 of stomach

able by this teehnic, we consider it to be far safer to rely on anastomosis in Y. Our experience indicates that when an end-to-side anastomosis has been performed under tension, the oesophagus is kept constantly under strain, and the vagus nerve is pulled upon with the result that the blood pressure drops and a poor result follows. (Table 33, 34)

Of a series of 20 cases of total gastrectomy, we have performed an end-to-side

In order to determine the extent of resection required in carcinoma of the oesophagus and the cardia, we have made a series of postmortem examinations and found that the infiltration by tumor cells extended usually from 1 to 2 cm. beyond the tumor mass, rarely as far as 3 cm.

on procedures supplementary to oesophagogastrostomy.

Result	Conditions of anastomosis at autopsy	Cause of death	Postoperative vomiting		Stenosis at autopsy
			milk	cooked rice	
Died on 3d day	Suture imperfect	Ruptured anastomosis?	Not clear		—
" " 50th "	Complete healing	Emaciation	—	—	—
" " 4th "	Almost complete healing	Empyema thoracis sinistra	—	—	—
" " 35th "	Complete healing	Emaciation	—	—	—
" " 14th "	"	"	—	±	±
" " 16 h "	"	"	—	+	+
" " 24th "	"	"	—	±	±
" " 2d "	Not perforated	Not determined	Not clear		—
" " 6th "	"	Empyema thoracis sinistra	—		—
" " 4th "	Perforated	Peritonitis due to perforation	—		—
" " 2d "	Not perforated	Not determined	Not clear		—
" " 9th "	Perforated	Empyema thoracis sinistra	—		—
" " 63d "	Emaciation	Emaciation	—	±	—
" " 14th "	"	"	—	+	—
" " 4th "	Perforated	Empyema due to perforation	—		—
" " 22d "	Complete healing	Localized empyema thoracis sinistra	—	+	—
" " 4th "	Not perforated	Bilateral empyema	—		—
" " 21st "	Complete healing	Emaciation	—	±	—
" " 5th "	Perforated	Empyema thoracis due to perforation	—		—

oesophago-jejunostomy in 14, saving 9 cases, an end-to-end oesophago-jejunostomy in 2, saving 1, and oesophago-duodenostomy in 4 cases, saving 2.

4. Fixation of the Oesophagus to the Chest Wall and Leaving the Oesophageal Stump Closed.

Resection of the oesophagus by fixing it to the chest wall, and leaving the oesophageal stump closed is far from being a desirable procedure, but it is sometimes the only method that can be used for the time being, when the general conditions of the patients are precarious. When the oesophageal stump is left closed in the dog, the

Table 32. The summary of the clinical series of oesopho-gastrostomy.

Patient	Technic of operation	Extent of resection			Results
		cm. above cardia	cm. along greater curvature	cm. along lesser curvature	
Semithoracotomic abdominal method					
T. O. ♂	End-to-side anastomosis of oesophagus to anterior wall of stomach and jejunostomy	5	8	6	Complete cure
K. O. ♂	,, without jejunostomy	3	12	6	Died from peritonitis
T. Y. ♂	,,	3	8	7	,,
K. H. ♀	,,	2	5	4	Complete cure
Y. S. ♂	End-to-end anastomosis	5	20	10	,,
Sh. H. ♂	,,	2	7	5	,,
K. H. ♂	,,	3	15	8	,,
Ta. Y. ♂	,,	4	10	4	,,
K. T. ♀	,,	4	11	6	,,
M. O. ♀	,,	2	20	8	Died
S. Y. ♂	,,	3	15	5	Died from pneumonia
Y. K. ♂	,,	3	22	7	Died from mediastinitis
I. O. ♂	,,	3	12	4	Cured
N. S. ♂	,,	2	10	4	Died from pneumonia
Free thoraco-laparotomy					
K. T. ♂	End-to-side anastomosis of oesophagus to anterior wall of stomach	7	10	5	Died from peritonitis
Y. K. ♂	,,	7	8	5	Died from Heart failure
Ch. Y. ♂	End-to-end anastomosis	8	8	5	Died from pneumothorax
Y. T. ♂	Einstülpungsresektion	6	—	—	Died from empyema
B. F. ♂	,,	6	—	—	Complete cure

healing of the stump is possible, but the ultimate prognosis of the animal is so bad that it can never be regarded as a desirable method, and yet it is not absolutely to be discarded.

A case of carcinoma of the thoracic oesophagus on which we have performed fixation of the oesophagus to the thoracic wall, appeared at first to be on way to recovery, but died from an inflammation which started at the fixed end of the oesophagus. (Fig. 50.)

Table 33. Summary of experimeuts on oesophagojejunostomy.

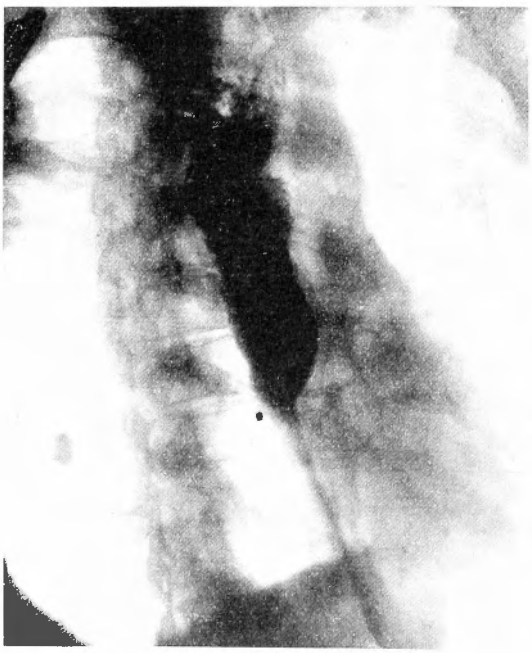
		Dog number	Technic of anastomosis and of suture	Results: Animals	Results: Anastomosis	Cause of death	Extent of resection (cm.)	Stenosis at autopsy
Abdominal oesophagojejunostomy (dogs)	End-to-side anastomosis with Braun's jejuno-jejunostomy	1	Mucosa of oesophagus to entire wall of jejunum; muscularis of oesophagus to serosa of jejunum	Died in 10 days	Healed	Empyema thoracis, left	25 (practically entire stomach)	—
		2		, , 4 ,,	Perforated	Peritonitis	3 (practically entire stomach)	—
		3		,, ,, 21 ,,	Healed	Emaciation	2 (,,)	—
		4		,, ,, 28 ,,			6	—
		5		,, ,, 3 ,,		Empyema thoracis, left	4	—
	Oesophgojejunostomy by modified Roux	1	Anastomosis covered with omental hood	,, ,, 19 ,,		Emaciation	3 (practically entire stomach)	—
		2		,, ,, 8 ,,		Empyema thoracis, left		—
		3		, ,, 4 ,,		Perforation in upper part of oesophagus; peritonitis	6	—
Transpleural oesophagojejunostomy (dogs)	End-to-side oesophagojejunostomy + Braun's jejuno-jejunostomy	1	Whole-thickess suture between oesophagus and jejunum; supplemented by Lembert's suture; anastomosis covered with omental hood	,, ,, 4 ,,		Empyema thoracis, left	4 (practically entire stomach)	—
		2		,, ,, 2 ,,		Not Clear	4 (practically entire stomsch)	—
		3		,, ,, 3 ,		Occlusion of mesenteric artery		—
		4		,, , 3 ,,		Not Clear		—
		5		, ,, 3 ,,				—
		6		,, ,, 4 ,		Incarcerated diaphragmatic false hernia	5	—
		7	Mucosa of oesophagus to entire jejunal wall; muscalacis of oesophagus to serosa of jejunum; anastomosis covered with omental hood	,, , 3 ,,		Empyema thoracis, left	3	—
	Oesophagojejunostomy by modified Roux's technic	1	Whole-thickness suture between oesophagus and jejunum; supplemented by Lembert's suture; anastomosis covered with omental hood	,, ,, 4 ,,		,	3 (entire stomach)	—
		2		,, ,, 3 ,,		Bilateral empyema thoracis	5 (one half of stomach)	—
		3		,, ,, 3 ,,		Empyema thoracis, left		—
		4		,, , 18 ,,		Emaciation	4 (entire stomach)	—

Table 34. Total gastrectomy.

			Up to 1930	During the year 1931	Total	
Number of cases operated on			8	12	20	
Result		Cured	4	8	12	20
		Died	4	4	8	
Skin incision	Middle line between xyphoid process and navel		3	0	3	
	Midline incision supplemented by a transverse or oblique secondary incision	Rib resection	2	10	12	17
		No rib resection	3	2	5	
	The skin incision extended over to the chest wall and thoracotomy was added.		1	1	2	
Anastomosis	Oesophagojejunostomy	End-to side anastomosis with Braun's jejuno-jejunostomy	2	12	14	16
		Roux's anastomosis	2	0	2	
	Oesophagoduodenostomy		4	0	4	
Jejunal fistula established			3	1	4	

Fig. 50.

a



b

Fig. 50 C

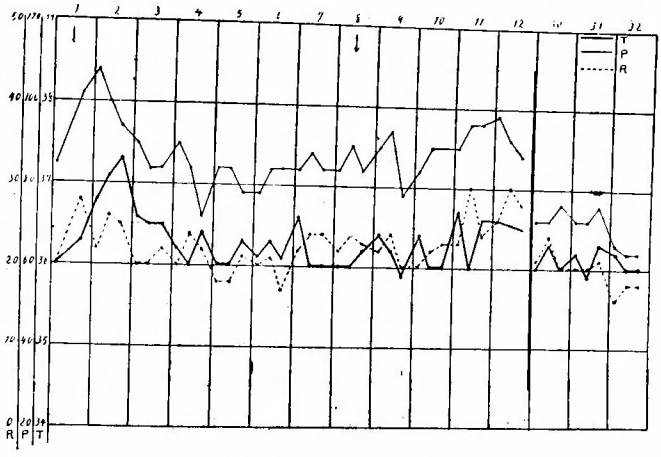


Fig. 50

a. S. K., aged 57 years, on whom radical resection was performed for carcimana of the lower part of the oesophagus, and a communication outside of the body was establlshed. Preoperative röntgenogram.

b. Postoperative photograph of the patient.

c. Postoperative temperature chart.

T...Temperature
P...Pulse
R ..Respiration

Table 35. The summary of the clinical series of oesophago-jejunostomy.

Patients	Age Sex	Location of tumor	Result
Yoneda	48 ♂	Lesser curvature of stomach and cardia	complete cure
Yoshioka	45 ♂	,,	,,
Ohata	60 ♂	Cardiac part	died
Yoshida	42 ♂	Lesser curvature of stomach involving the cardia	,,
Yasuno	21 ♀	Both curvatures of stomach	complete cure
Matsu	61 ♂	Lesser curvature and pylorus	,,
Yanagi	52 ♂	,,	died
Matsuoka	47 ♀	Lesser curvature of stomach involving cardia	complete cure
Yamakawa	57 ♂	,,	,,
Sugimoto	34 ♀	Lesser curvature and pylorus	died
Saen	51 ♂	Lesser curvature of stomach involving cardia	complete cure
Saita	54 ♂	,,	,,
Oe	40 ♂	,,	died
Sakuma	49 ♂	,,	,,
Shimakawa	52 ♂	,,	complete cure
Ohta	38 ♂	Pylorus involving lesser curvature	,,

Total	16	completely cured d.ed	10 6
Oesophagoduodenostomy	4	completely cured died	2 2
Grand total	20	complete cure	12

5. *The Penetration Method and the Extirpation of the Carcinoma of the Oesophagus in Two Stages.*

Since our studies on the nutrition of the oesophagus has shown that the major part of the blood supply to the entire gullet is derived from the oesophageal branches of the bronchial arteries, an operation for a tumor at the tracheal bifurcation, which requires ligation of this artery, will naturally necessitate a resection of the greater part of the thoracic oesophagus. The penetration method has been the sole means of accomplishing this, but in our experience, the method has a very serious defect of difficulty of closure of the chest cavity after the operation.

In our technic of two-stage operation, an external cervical oesophagostomy and gastrostomy are performed in the first stage, and when the nutritional condition of the patient has recorved and the wounds healed, the thorax is opened, the tumor removed, the distal stump of the oesophagus is invaginated into the region of the cardia. In this way, the thoracic cavity may be closed air-tight and the safety of the procedure is asured. In our single case, it was possible to accomplish the resection and closure of the chest completely, but owing to dense adhesions that existed between the tumor and the right vagus nerve, the latter was considerably traumatized and torn, which caused lowering of the blood pressure and pulse rate, resulting in death 6 days after the operation. (Fig. 51, 52.)

Fig. 51. Resection of the oesophagus by two stage penetration method. (1)

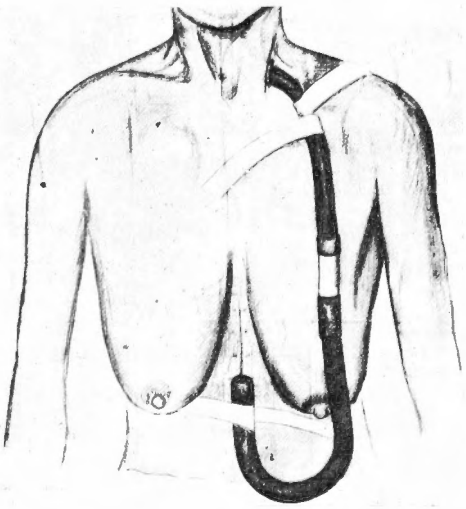
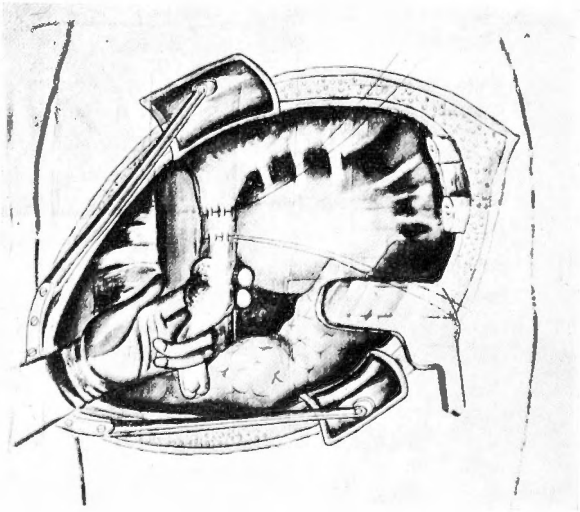


Fig. 52. Resection of the oesophagus by two stage penetration method. (2)



Chapter III. Incision and Suture of the Oesophagus.

1. Incision of the Oesophagus.

When occasions rise that necessitate an incision of a normal oesophagus, it should be made longitudinally and as short as possible, and its repair should be made by layer sutures transversely to the incision. In this way, healing is facilitated and stenosis prevented, as our experiments on the dogs have demonstrated. (Table 36.)

2. Side-to-side Oesophago-gastrostomy.

The magnitude of surgical procedure and danger involved in a side-to-side gastro-oesophagostomy are equal to those attending the resection of the cardia, and are in this sense incomparable to gastro-enterostomy, and the operation is practicable only in the lower segments of the oesophagus. It is performed limitedly on cases of idiopathic oesophageal dilatation and deep-seated diverticula. We have performed this operation on cases of carcinoma of the pancreas involving the cardia and of elongatio oesophagi presenting a disturbance of passage through the cardia. The results were invariably bad. The operation on a case of carcinoma of the pancreas (including the cardia) which was performed 3 years ago was followed by death on the tenth postoperative day on account of incomplete healing of the anastomosis. Encircling the anastomosis with the great omentum had not been practiced at that time.

3. The Oesophago-cardioplasty.

This operation is performed on the cases of idiopathic oesophageal dilatation. Our technic consists of completely liberating the cardiac portion of the oesophagus at the hiatus, under free thoracotomy, then making a longitudinal incision of the cardiac portion extramucosally by Gottstein's technic, and finally suturing the incision transversely by the layer technic. The closure of the diaphragmatic and thoracic wounds without suturing the oesophagus to the oesophageal hiatus completes the operation. (See Fig. 48.)

The number of cases upon which we have operated by this method totals six with complete cure in all. (Table 37.)

4. The Method of Closing the Oesophageal Stump.

In dealing with an oesophageal stump within the mediastinum, which possesses little resistance to infectious microorganisms, or the thoracic cavity, it is highly essential to accomplish the suture absolutely aseptically. If the suture is introduced from outside of the delicate musculature as in ordinary intestinal suture, the procedure is frequently not aseptic. For this reason, we have made it our practice to incise circularly through

Table 36. Summary of experiments on

Series			I			II	
Incision on the oesophagus			Longitudinal 5–5.5 cm.			Longitudinal 2–2.5 cm.	
Suture		Direction of suture	Longitudinal			Transverse	
		Method	W.L.	M.Ms.L.	M.Ms.	W.L.	M.Ms.L.
Postoperative Condition	Appetite	Good	2	0	1	3	1
		Poor	1	3	2	0	2
	Nausea	Present	1	0	3	3	3
		Absent	2	2	0	0	1
	Vomiting	Present	1	3	3	2	3
		Absent	2	0	0	1	0
Number of days survived			9–14	12–65	20–50	18–25	14–41
Infection		Subcutaneus	1	1	0	0	0
		Oesophageal fistula formed	2	0	0	1	0
Autopsy		Normal	1	2	3	2	3
		Stenosis	0	0	0	0	0

W.=whole thickness, L.=Lembert suture, M.=Mucosa, Ms.=Muscularis.

the muscular coat first, doubly ligating the mucosal coat and dividing it with actual cautery between the ligatures, the stumps being buried beneath the muscular coat by an invaginating suture, and finally burying the entire stump with purse-string suture far up into the segment of the oesophagus which is richly supplied with blood.

Chapter IV. The Oesophagoplasty.

Antethoracic oesophagoplasty is the operation generally recommended at present. There are several ways of performing this operation, of which the method that was proved by our experiments on the dog as least dangerous is the one that utilizes a skin-intestinal tube, supplemented by overlapping the entire new canal with the great omentum which prevents circulatory failure of the isolated intestinal segment. A tube made of a portion of the stomach (Jianau's operation) was found to be ever liable to circulatory disturbance.

In a case of cicatricial stricture of the oesophagus which could not be relieved by any other method of treatment, we were able to complete an antethoracic oesophagoplasty by means of skin-intestinal tube. This is the first case of successful antethoracic oesophagoplasty in our country. (See Fig. 56, 58 & 59.)

the technic of incision and suture.

	III			IV			V		
	Longitudinal 5–5.5 cm			Longitudinal 2–2.5 cm			Transverse, half the circumference of oesophagus		
	Transverse			Transverse			Transverse		
M.Ms.	W.L.	M.Ms.L.	M.Ms.	W.L.	M.Ms.L.	M.Ms.	W.L.	M.Ms.L.	M.Ms.
2	1	3	3	3	3	2	0	0	2
1	2	0	0	0	0	1	3	3	1
2	2	0	0	0	1	2	3	1	3
1	1	3	3	3	2	1	0	2	0
2	2	0	0	0	0	2	3	1	3
1	1	3	3	3	3	1	0	2	0
26–54	21–29	12–26	13–62	21–30	8–34	19–28	8–17	15–20	19–24
1	0	0	1	1	0	0	1	0	0
0	2	0	0	0	1	0	1	0	0
3	1	3	3	3	1	3	1	3	3
0	0	0	0	0	1	0	0	0	0

Regarding the possibility of utilizing a non-pedicled fascial transplant in repair of the oesophageal wall, our experiments on the dog indicate that a transplant up to 4 cm. long and half the circumference of the oesophagus takes well and functionates as an artificial oesophagus. (Table 38.)

Chapter V. Gastrostomy and Gastrotomy.

Gastrostomy as a last resort in the treatment of stricture of the oesophagus is a thing of the past. It is at present a preliminary or supplementary measure for other more radical operations, as, for instance, in the treatment of carcinoma of the oesophagus or as a part of to-and- fro bougie dilatation of the stricture.

Gastrotomy is utilized in extracting a foreign body in the deeper parts of the oesophagus. Our practice of performing a free thoracotomy in addition to gastrotomy, and extracting a foreign body in the oesophagus bimanually is, we believe, the most logical method. (Fig. 53 and See Fig. 89, 90, 91 & 92.)

Chapter VI. The Postoperative Functions.

Before discussing the postoperative functional conditions, it may be pointed out that histologically the anastomosis between the oesophagus and the stomach or jejunum is

Table 37. A summary of the results of surgical treatment of idiopathic dilatation of the oesophagus by oesophago-cardioplasty.

Patient	Age sex	Chief complaint	Age of onset	Preoperative röntgenologic study	Reaction to atropin, pilocarpin, adrenalin	Date of operation	Technic of operation	Post operative X-ray findings	Results
G. N.	20 ♂	Vomiting pain on deglutition	16	Marked dilatation of oesophagus; stenosis at cardia.	+ + +	Dec. 10th, 1927	Oesophago-plasty with complete isolation at hiatus.	Passage of fluid complete in 13 seconds	Complete cure
S. K.	34 ♂	Vomiting difficulty of deglutition	30	Stenosis of oesophagus a few cm. above diaphragm; moderate dilatation above it.	+ + +	June 15th, 1929	,,	Passage of fluid complete in 3 seconds	,,
M. Y.	34 ♂	Vomiting sensation of stagnation of food	24	Complete obliteration of the lower end of oesophagus; moderate dilation of overlying part.	+ + +	June 3d, 1931	,,	Passage of fluid in 3 minutes	,,
K. Y.	43 ♀	Vomiting sensation of stagnation of food	19	Complete obliteration of lower end of oesophagus; moderate dilatation above.	+ + −	July 11th, 1931	,,	,,	,,
T. S.	27 ♂	Sensation of stagnation of food	23	Complete obliteration of lower end of oesophagus; moderate dilatation above.	+ + −	Aug. 1st, 1931	,,	,,	,,
Y. T.	44 ♂	,,	38	Stenosis of cardia; marked dilatation of oesophagus.	+ + −	Nov. 18th, 1931	,,	,,	,,

Table 38. Summary of experiments on repair of the oesophagus with nonpedicled fascial transplant.

Method of Suture	Single layer	do	do	do	do	do	do	do
Animal number	1	2	3	4	5	6	7	8
Number of days survived	50	20	30	4	20	10	4	12
Length of oesophagus resected (cm)	3.0	4.0	4.0	4.0	3.0	4.0	4.0	3.0
Necrosis of fascial transplant	−	−	−	+	−	+	+	+
Formation of fistula	−	−	−	+	−	−	+	−
Mediastinitis	−	−	−	−	−	−	+	−
Perioesophagitis	−	−	−	+	−	−	+	+
Degree of stenosis of the oesophagus	−	+	±		++	++		++
Degree of adhesion	+	++	+	−	++	++	−	++
Cause of death		Stenosis		Inflammation	Stenosis	Stenosis	Stenosis	

complete in about 4 weeks' time.

An X-ray study after resection of the lower part of the oesophagus naturally does not show a cardiac function at the site of anastomosis between the oesophagus and the stomach or the jejunum. (Table 39.) In some forms of anastomosis, such for instance, as Witzel's method, there is brought out a definite stenosis at the site of anastomosis, but in those in which two layer suture or Kader's technic was supplemented by application of the omental hood, there is no narrowing of the lumen recognizable.

Fig. 53. Combined method of ex raction of foreign body. (skematic)

Effects of bilateral section of the vagus nerves in resection of the cardia upon the motility of the remaining portion of the stomach are of great academic as well as practical interest. Owing to the rarity of cures after such operations hitherto, no description of such effects is available in the literature. Of the eight cases that were cured, we have made postoperative röntgenologic studies on six cases, and found that, with exception of one case, there was a definite pyloric dilatation with delayed passage, but that the gastric peristalsis is not markedly affected. (Table 40.) Likewise in seven out of twelve cases of total gastrectomy in which the both vagi were cut, a röntgenologic evidence of delayed passage or a marked disturbance of the intestinal peristalsis could not be obtained. (Table 41.)

We have also studied the basal metabolism of the cases in which resection of the cardia for carcinoma and total gastrectomy were performed, compared the results with the preoperative metabolic rates, and tried to obtain an insight into the effects on the vital functions. Six cases which had been operated upon for carcinoma of the cardiac portion of the oesophagus showed a well marked reduction of the basal metabolism in the second and third postoperative weeks, but the preoperative reading was recovered in about six weeks, tending to rise thereafter. (Table 42.)

Table 39. Behaviour of oesophagus after section of its cardiac part.

Patient		Technic of Operation	Dilatation	Peristaltic and antiperistaltic waves	Time required for passage of contrast meal	Stenosis
T. O.	♂ 50	Examined 55 days after anastomosis between the oesophageal stump and the anterior wall of the stomach (end-to-side Witzel's method)	+	+	1′—15″	÷
Y. S.	♂ 51	50 days after end-to-end anastomosis between the oesophagus and the greater curvature of the stomach	÷	−		−
S. H.	♂ 54	30 days after ,, ,,	−	−	15″—17″	−
T. H.	♂ 45	38 days after ,, ,,	−	−	9″—12″	−
G. Y.	♂ 47	45 days after ,, ,,	−	−	7″	−
K. T.	♀ 62	36 days after ,, ,,	−	−	7″	−

N.B. Cardiac function was absent in all cases. In those cases in which perislaltic waves appeared, the bolus was passed to the stomach little by little at each peristalsis; in those not showing the peristalsis, the bolus passed continuously into the stomach.

Table 40. Effects of bilateral section of the vagus nerve on the motility of the part of the stomach left after resection of the cardia for carcinoma.

Patient	Contour of the stomach		Peristalsis	Pylorus	Emptying time	Residue
					Hours Minutes	
T. O.	Displaced toward left	Small	Slightly	Insufficient	6 35	−
S.	,,	,,	,,	,,	4 50	+
S. H.	,,	,,	,,	,,	5 30	−
H.	,,	,,	Strong	,,	4 25	+
Y.	,,	Narrow	,,	,,	6 50	−
K. T.	,,	,,	,,	Complete	3 00	+

Chapter VII. Preoperative and Postoperative Treatments.

Since the patients, on whom an operation on the oesophagus is indicated, are poorly nourished and their resistance is lowered, the necessity for preoperative nutritional

Table 41. Intestinal mobility after total gastrectomy.

Patient	Jejunum below anastomosis			Time required for passage of bolus through the small intestine		
	Dilatation	Peristalsis		hour	minutes	
K. Y.	+	−	−	3	30	To the coecum
T M.	+	−	+	4	10	To the end of the ascending colon
S. Y.	+	−	−	5	50	To the origin of the ascending colon
H. M.	+		−	5	10	To the coecum
T. Y.	+	−	+	4	15	To the middle of the transverse colon
K. S.	+	−	+	Bolus stayed in the dilated jejunum for 3 hours		
U. S.	−		−	4	00	To the coecum

Table 42. Summary of the basal metabolic rates of the patients on whom resection for carcinoma of the cardia was performed.

Name of patient	Time examination made	O_2	CO_2	R. Q.	G u.	Increase (+) or Decrease (−)
K. H.	Preoperative	1.34	1.10	0.82	950	− 5%
	52 days postoperative	1.28	0.95	0.74	894	− 7%
Y. S.	33 days postoperative	1.67	1.37	0.82	1179	+ 4%
	54 days postoperative	1.67	0.39	0.83	1183	+ 5%
S. H.	Preoperative	1.82	1.20	0.66	1248	+ 8%
	24 days postoperative	1.50	1.33	0.88	1076	− 4%
	99 days postoperative	1.71	1.33	0.77	1200	+ 8%
S.H.K.	Preoperative	2.09	1.57	0.73	1453	+13%
	14 days postoperative	1.63	1.32	0.81	1151	− 5%
K. Y.	Preoperative	1.57	1.31	0.83	1112	+ 3%
	46 days postoperative	1.50	1.21	0.87	1059	+ 5%
R. T.	Preoperative	1.69	1.26	0.84	1199	−21%
	23 days postoperative	1.41	1.23	0.86	1009	− 5%

management is urgent. For this purpose, a preliminary gastrostomy or jejunostomy is frequently called for. Transfusion of blood, especially that administrated previous to the operation is also effective.

During thoracotomy in general, but on the right side most emphatically, an

inhalation of oxygen is indispensable. Postoperative pneumothorax and hydro- or haemothorax should be constantly watched for, and if found, promptly aspirated. Pneumonia and other infectious processes should be prevented by a thorough immunization. In performing anastomosis between the oesophagus and the stomach or the jejunum, a routine jejunostomy is not necessary. Allowing liquid food by mouth a few days after the operation is not harmful.

Section IV. Brief Consideration of Surgical Diseases of the Oesophagus.

In this section I shall discuss only those diseases which I have actually studied, and these only briefly, the detailed discussion being presented in my original report in Japanese.

Chapter I. Congenital Deformities.

Of the various congenital anomalies of the oesophagus, namely, congenital stenosis, congenital stricture, true diaphragmatic hernia of the oesophagus, and dysphagia lusonia, we have had opportunities to study a case of congenital stenosis, and two cases of congenital stricture, that had been observed at the Pediatric Clinic of the University. The former case was that of a new born infant 5 days old, in which the postmortem examination showed that the oesophagus ended as a blind sac at a distance of 4.5 cm. from the larynx, that is at the level of the tracheal bifurcation. One of the latter cases was that of an infant one year and two months after birth, in which the oesophagoscopy revealed an opening suggesting a diverticulum at a distance of 14.5 cm. from the larynx, that is, at the level of the tracheal bifurcation, and 1.5 cm. beyond it the oesophageal lumen suddenly narrowed and presented a picture resembling the cervix of the uterus. The other was that of a child 7 years and 1 month old in whom a stenosis at the cardia and dilatation immediately above it were demonstrated by an X-ray examination. In none of these cases any special treatment was given.

Chapter II. The Injuries.

We have had two cases of injuries of the oesophagus complicated by perforation. In the first case, the perforation was caused by an untimely employment of bougie two weeks after swallowing sulphuric acid, the perforation being located at the level of the tracheal bifurcation. In the second case, the laryngeal part of the oesophagus has perforated after being oesophagoscoped. Both cases developed mediastinitis, and died in a few days, the second case having been further complicated with empyema thoracis.

Chapter III. The Oesophageal Fistula.

It is rare to see a permanent fistula develop from a fresh wound. Most of the fistulae have as their background some chronic changes in the wall of the oesophagus, such as carcinoma. We have seen a case of fistula that had developed from an incision made for perioesophagitis secondary to carcinoma of the larynx.

Two cases of oesophagobronchial fistula were observed by us. In one of these, the fistula was recognized by X-rays and oesophagoscopy to be located at the tracheal bifurcation, but died from a complicating gangrene of the lung. The second case had a traction diverticulum and a fistula at a distance of 31 cm. from the level of the larynx, showed a positive blood Wassermann reaction, and was cured by tube feeding and the antisyphilitic treatment.

We have observed, in addition, a case each of paralytic disturbance of deglutition and carcinoma of the upper orifice of the oesophagus which caused entrance of food into the trachea, but both cases proved fatal.

Chapter IV. The Inflammatory Diseases and Ulcer of the Oesophagus.

Although an acute catarrhal inflammation may result from any physical or chemical irritation of the mucosa, such as that caused by ether anaesthesia in surgery, yet patients consulting us ordinarily complain of a sense of stagnation caused by a chronic inflammatory condition. Such a condition may occur in drinkers and smokers, and it should be carefully differentiated from chronic organic diseases. Of three cases which we had observed, it was possible to establish a differential diagnosis in two, but in the third case, we were misled by a röntgenologic evidence of stagnation of barium meal, caused by an accumulated secretion, and we opened the thorax under a mistaken diagnosis of carcinoma of the lower part of the oesophagus.

Inflammation due to corrosion caused by swallowing chemical agents such as acids or alkali is most frequently observed among inflammatory diseases. In the previous year we observed two fatal cases in which the inflammation resulted from swallowing of concentrated sulphuric acid.

On other cases of similar nature it was possible to try various methods of treatment. These were due to sulphuric acid, two cases; hydrochloric acid, one; acetic acid, one; nitric acid, one; sodium hydroxyd, one; and lysol, one case. In the lysol case, it was possible to prevent the development of stricure by an almost immediate lavage. For sometime after swallowing a corrosive material, deglutition is usually possible, the evidence of stricture occurring about a month later.

Suppurative inflammation may occur as a consequence to swallowing a sharp pointed foreign body. We have had opportunities to treat two cases of this nature.

The first patient developed purulent oesophagitis after swallowing a fish hook (that used for eel), the hook was extracted and the cure was effected by subsequent intra-oesophageal evacuation of pus. The second patient swallowed a fish bone, and developed a purulent oesophagitis, for which intraoesophageal incision was made, but the outcome was fatal.

Chapter V. Stricture by Scar Contraction.

Stricture due to scar contraction usually occurs as a consequence of swallowing corrosive chemicals. Between the third and fourth weeks after the accident, ulceration is most extensive, and it is usually later than the end of the eighth week that scar formation takes place.

Numerous therapeutic measures have been elaborated and tried by clinical workers in the past, and these are briefly described as follows.

Methods of treatment of stricture of the oesophagus by scar contraction.

A. Nonsurgical treatment.
   - Method of dilatation.
   - Early bougie therapy.

B. Surgical methods.
   1. Oesophagostomy.
   2. Mediastionotomy.
   3. Resection of strictured segment.
   4. Gastrotomy.
   5. Gastrostomy.
      - Hacker's to-and-fro bougie dilatation.
   6. Exclusion of strictured segment.
      a) Oesophago-gastrostomy.
         i) Transpleural
         ii) Transabdominal.
      b) Antethoracic Oesophagoplasty.
         i) Formation of oesophageal tube with skin.
         ii) Formation of oesophageal tube with small intestine.
         iii) Formation of oesophageal tube with small intestine and skin.
         iv) Formation of oesophageal tube with colon.
         v) Formation of oesophageal tube with stomach.

Of a great interest is the recent innovation of a method in which a bougie is introduced as a preventive measure against stricture from 2 to 6 days after the corrosive agent is swallowed. In this method, the bougie introduction is made daily,

Fig. 54. The case successfully treated by Hacker's to-and-fro bougie dilatation. The patient, R. O., female, aged 4 years.
Röntgenogram before beginning the treatment.

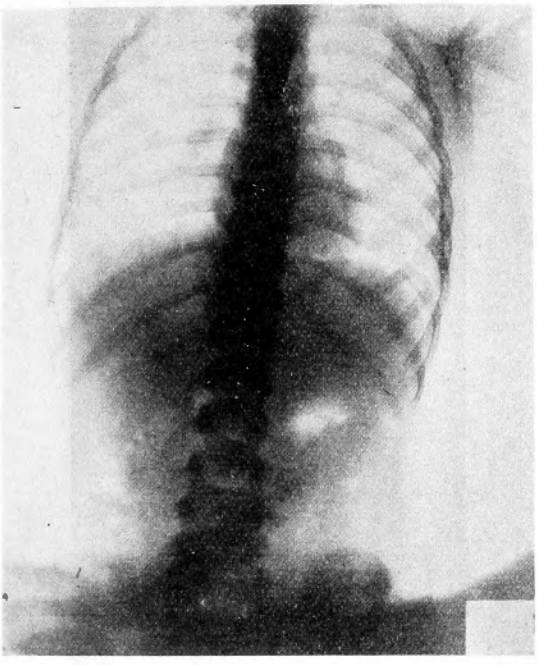


Fig. 56. Röntgenogram after the course of treatment.

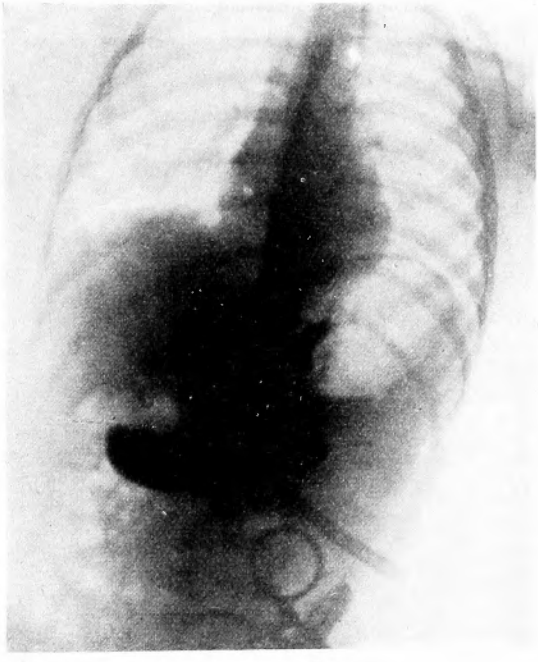
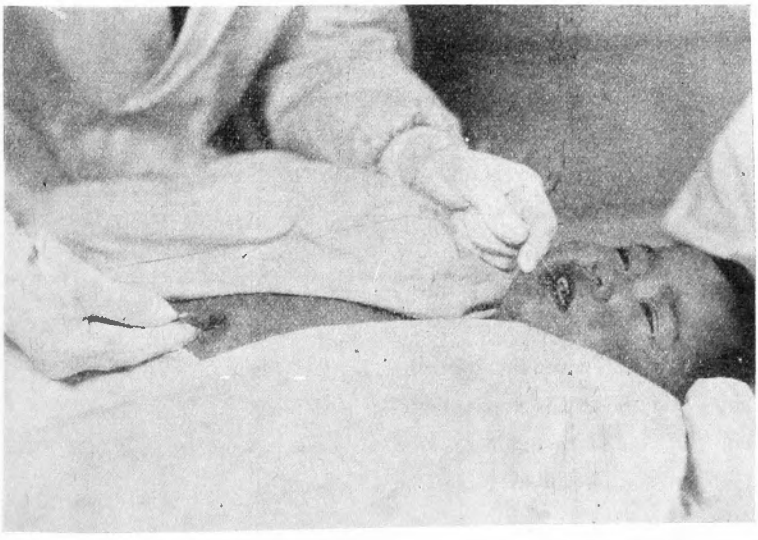


Fig. 55. Photograph of the patient during a treatment.



later on the interval between successive treatments being gradually increased. Although excellent results appear to have been obtained by those who practice it, a painstaking precaution against perforation must necessarily be exercised. The cases of perforation that were brought to our clinic, mentioned previously, were both victims of early bougie application, although the technic of application did not seem to be a correct one.

The type of cases that we meet with most frequently is that in which the cicatricial stricture has already been established, and the therapy must be directed toward its

Fig. 57. The case of cicatricial stricture, successfully treated by antethoracic oesophagoplasty. The patient, F. K., female, aged 24 years. Preoperative röntgenogram.

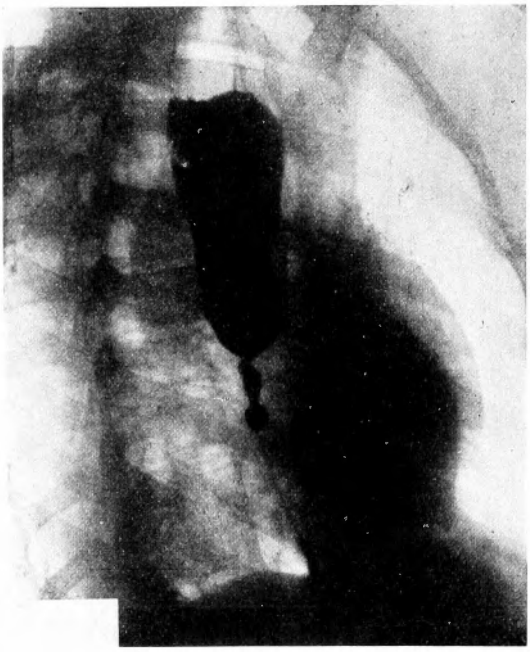


Fig. 58. Postoperative photograph of the patient.

dilatation. Although it would be most fortunate if it is possible to accomplish dilatation without taking a recourse to surgical operation, yet the past experience has taught us that the prime concern in the mechanical dilatation must be centered on prevention of perforation. A measure which is absolutely safe in this respect, available at present is the to-and-fro bougie method devised by von Hacker. In this method, a success in passage of a silk thread through the stricture is half the success of the treatment, the only surgical measure necessary being gastrostomy. We have had a case of a child 4 years old, in whom there were two strictures of the oesophagus, following an ingestion of sodium hydroxyd, one located at the second and the other at the third constrictions. The upper stricture was relieved by the usual bougie dilatation, while the lower one remained resistant, and there was a possibility of perforation, if an energetic attempt at mechanical dilatation were to be made. For this reason, we have employed Hacker's to-and-fro method and succeeded in a cure in 80 days.

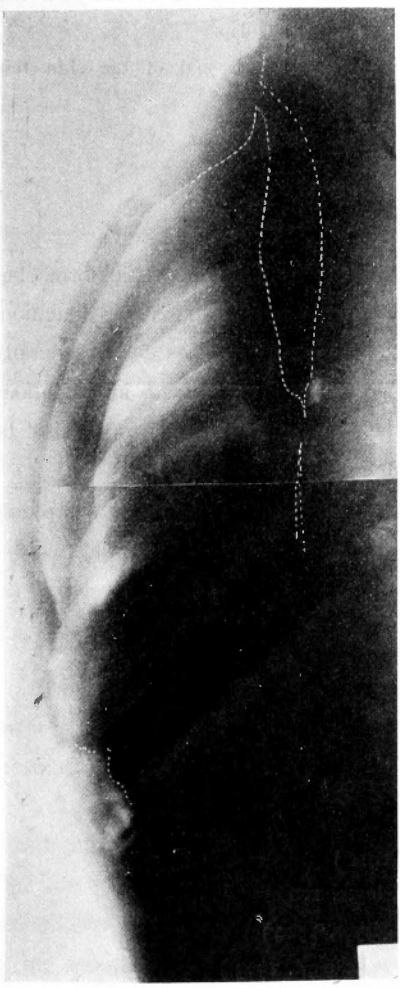
Patient R. O., 4 years old, ♀. (Fig. 54, 55, 56.)

June 15th. Admitted. Body weight 10.9 kg.

June 17th. Oesophagoscopy revealed a cicatricial stricture 11.5 cm. from larynx.

June 19th to July 8th. Ordinary bougie dilatation (8 times).
July 8th. Second stricture found at 19–20 cm. Body weight 12.0 kg.
July 21st. Gastric fistula made.
September 15th. To-and-fro bougie dilatation applied. No. 1, 2 passed (No. 3 diameter 0.5 cm. applied.)
September 28th. No. 4 (diameter 0.61 cm.) passed. Rice juice passed.
October 18th. No. 5 (0.8 cm.) passed easily. Body weight 12.7 kg.
November 8th. No. 6 passed. Can eat macaroni, cooked rice.
November 24th. No. 7 (0.9 cm) passed.
December 5th. Treatment concluded, and the apparatus withdrawn.
December 12th. Gastric fistula closed spontaneously.
December 19th. All foods are readily passed. Body weight 13.5 kg.

Fig. 59. Postoperative röntgenogram.



(Abbe's technic in which string friction is applied through the oesophagotomy and gastrotomy wounds has not been tried by us).

In those complicated cases in which even Hacker's method of dilatation is not applicable, it is advantageous to perform antethoracic oesophagoplasty instead of attempting other risky operative measures. With antethoracic oesophagoplasty, the operative procedure is the safest one, and the postoperative passage of food is satisfactory. In a case of highly complicated strictures following ingestion of sodium hydroxyd, on which it was impossible even to employ a to-and-fro bougie dilatation, we have applied the technic of antethoracic oesophagoplasty by means of a tube made of skin and jejunal segment, which was found by our animal experiments to be the most efficacious. As the photograph shows, the postoperative passage of food is satisfactory, and the patient is able to enjoy meals exactly like a normal individual, and appears even better nourished than before the accident. The case is the first one to be reported in this country.

A brief record of a case of cicatricial stricture treated by antethoracic oesophagoplasty.

[Patient, a woman 24 years of age. (Fig. 57, 58, 59.)]

Date	Treatment
May 29.	Gastric fistula established.
August 5. (69 days after gastrostomy.)	Antethoracic displacement of the jejunum. (First stage.)
August 29. (25 days after the first stage operation.)	Oesophagotomy. (Second stage.)
Sept. 30. (57 days after the first stage operation.)	Formation of antethoracic tube. (Third stage.)
October 12.	Fistula developed at the lower end of the skin tube.
October 21. (78 days after first stage operation.)	Fistula developed on a side at the upper end of the skin tube.
October 31. (78 days after first stage operation.)	Skin graft.
February 19, 1932. (192 days after the first operation.)	Fistula at the lower end of the skin tube closed by skin flap.
March 3. (210 day after the first stage operation.)	Fistula at the upper end of the skin tube closed by skin flap.
March 13.	Gastrostomy tube removed.

Chapter VI. Functional Diseases of the Oesophagus.

Functional diseases of the oesophagus occur either in paralytic or spastic form, but the only one in which surgeons are interested is the so-called idiopathic dilatation. That this disease is caused by dysfunction of the vagus nerve has been generally recognized by students of this subject, but in the light of the recent investigations carried out in our clinics, functional disorder of the sympathetic nerve must also be recognized as a causative factor, as elsewhere point out.

Various therapeutic measures have been devised hitherto for relief of the symptoms of the disease.

Methods of Treatment for Idiopathic Dilatation of the Oesophagus.

A. Non-surgical Methods.
   - I. Medical treatment.
   - II. Mechanical dilatation.

B. Surgical Methods.
   - I. To-and-fro bougie dilatation. (E. Martin, 1900.)
   - II. Operations upon dilated segment.
     1. Thoracic oesophagostomy. (Zaaijer, 1911.)
     2. Resection of oesophageal wall. (Reisinger, 1906.)
     3. Plication of oesophageal wall. (W. Meyer, 1910.)
     4. Reduplication of the oesophagus. (E. Leonard, 1923.)

III. Operations upon the nerves.
   1. Isolation and section of the vagus nerve. (W. Meyer, 1910.)
   2. Exairesis of the phrenic nerve. (Enderlen, 1929.)

IV. Operations upon the cardia.
   1. Surgical dilatation. (Mikulicz, 1903.)
   2. Cardioplasty. (Wendel, 1909.)
   3. Incisions of the musculature of the cardia. (Heller, 1913.)
   4. Excision of the musculature of the cardia. (Juracz, 1925.)
   5. Liberation of the oesophagus from its surrounding structures. (v. Hacker, 1913.)
   6. Resection of the cardia. (Rumpel, Bier, 1920.)
   7. Extirpation of lymph-glands from the musculature of the cardia. (R. Carsky, 1929.)
   8. Incision of the hiatus and oesophagoplasty (Oesophagoplasty with isolation at the hiatus). (Ohsawa, 1932.)

V. Exclusion of the cardia.
   1. Oesophago-gastrostomy. (Heyrovsky, 1910.)
   2. Plication of the cardia. (Lambert, 1914.)

Table 43. Summary of results of therapeutic procedures for idiopathic dilatation of oesophagus.

Methods treatment	Total number of cases	Completely cured	Improved	Not improved	Recurrence	Death
Medical treatment	56	12.5%	50.0%	28.2%	—	8.9%
Nonsurgical dilatation	96	31.2%	53.0%	4.1%	9.3%	2.0%
Surgical dilatation	57	13.7%	70.1%	1.7%	8.7%	3.5%
Incision of cardiac muscles	45	37.7%	51.1%	6.6%	2.2%	2.2%
Oesophagogastrostomy	28	60.7%	36.0%	—	—	3.6%
Cardioplasty	21	14.3%	66.6%	4.7%	4.7%	9.5%
Oesophagoplasty with liberation at the hiatus	6	80.0%	20%	—	—	—

Of these, a mechanical dilatation of the cardiac orifice is uncertain in its result, and carries with it a danger of possible perforation. We have, therefore, adopted a method of surgical dilatation of the constricting region, entirely discarding the blind-folded procedure of mechanical method.

Submucous incision has made the oesophago-cardioplasty a perfectly aseptic operation. Our method, in which the muscles at the oesophageal hiatus are divided and the oesophagus completely mobilized, in addition to the special form of incision and suture of the oesophagus employed, has further rendered the operation safe and certain of

Fig. 60. The case of idiopathic oesophageal dilatation, on which oesophagoplasty (with liberation at hiatus) was performed. Preoperative röntgenogram.

Fig. 61. Postoperative photgraph of the patient, T. A., male, aged 43 years.

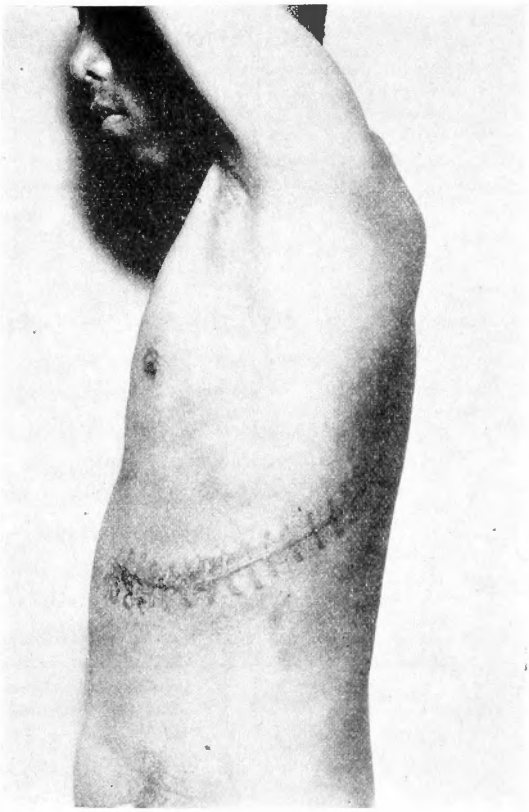
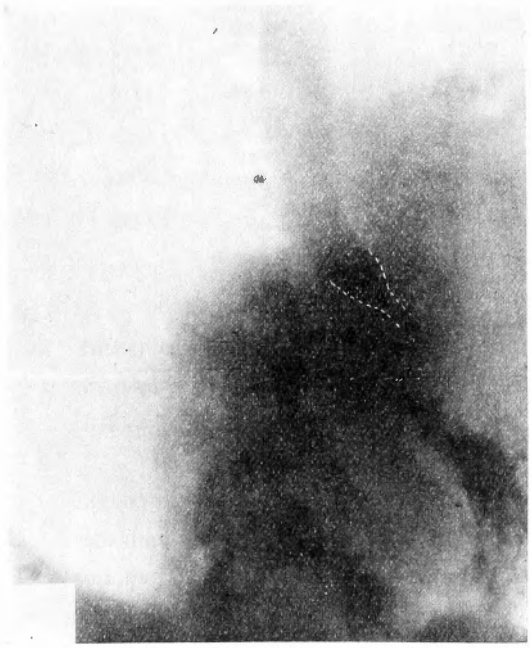


Fig. 62. Postoperative röntgenogram.

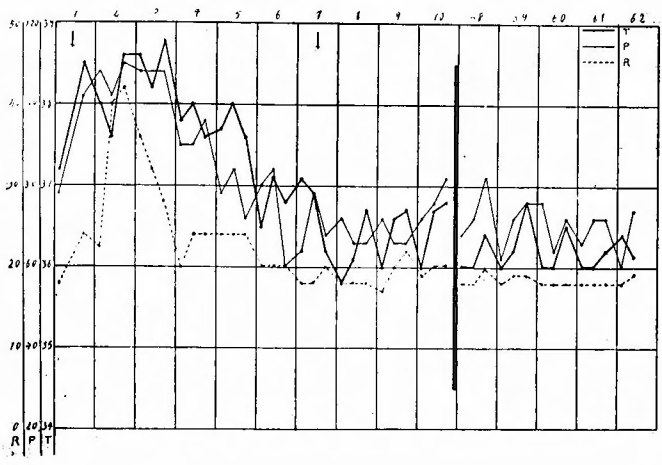


result. This point is well demonstrated by the fact that all of the six cases treated by this method were completely cured. We repeat that in the treatment of idiopathic oesophageal dilatation, the oesophago-cardioplasty with liberation of the involved segment of the oesophagus should be adopted and all other methods be discarded. (Fig. 60, 61, 62, 63.)

Chapter VII. The Elongated Oesophagus.

Descriptions of abnormal movements and stretching of the lower part of the oesophagus appear in the literature, but there is no one who considered such pheno-

Fig. 63. Temperature chart. (Case shown in Fig. 61)



T=Temperature
P=Pulse
R=Respiration

mena as constituting an independent disease, or who proposed a special form of treatments. We regarded the oesophagus presenting these signs as constituting a definite clinical entity, like in the case of colon elongatum, and especially elongated sigmoid colon, and devised a method of treatment from this standpoint. Quite naturally, neither röntgenologic nor pharmacodynamic test shows any evidence of functional disorder in this disease.

In two cases of this type, we have tried operative measures. In one case, Sauerbruch's Einstülpungs-resektion was done, with complete relief of difficulty of deglutition which was present before the operation. In the other case, we have performed an oesophagogastrostomy, but the patient died. At postmortem examination the oesophagus was found to be 29 cm. long, fully 5 cm. longer than the average length among the Japanese, which is 23.85 cm. according to Taniguchi, and 23.4 cm. according to Yokoyama. There was, however, no marked dilatation. (Fig. 64, 65, 66, 67.)

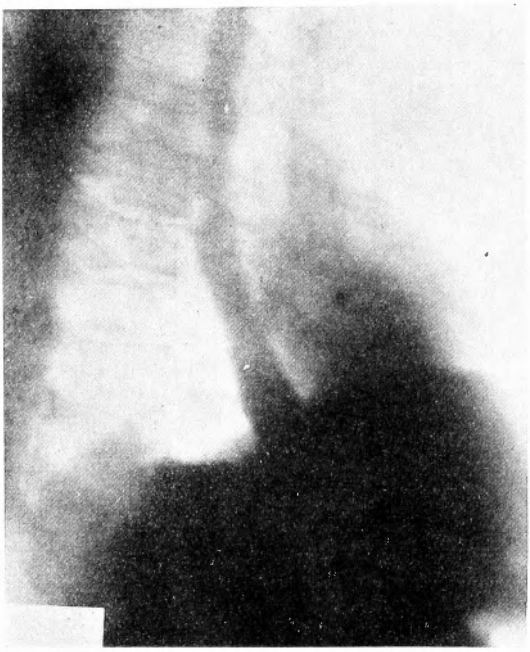
Chapter VIII. The Oesophageal Diverticula.

Case reports of this anomaly are found not infrequently in the European and American literature, but extremely few cases have been reported in our country, and these are classified as follows :—

	Border line diverticulum	Deeply located diverticulum (thoracic)	Traction diverticulum	Dignosis not recorded	Grand total
Total number of cases	427	49	29	16	521

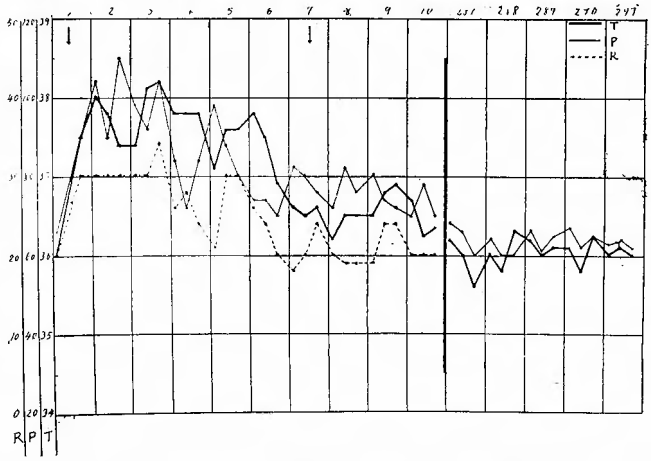
The magnitude of the operation for radical extirpation of the diverticulum is about equal to incision and suture of the oesophagus, and the result of the operation is

Fig. 64. The case of elongatio oesophagi. Preoperative röntgenogram.



excellent. We have studied a case of typical diverticulum of the thoracic oesophagus but unfortunately could not obtain a consent for an operation. A case of traction diverticulum which perforated into the bronchus with formation of a oesophagobronchial fistula was cured by tube feeding and antiluetic treatment. Another case that resembled Zenker's divaticulum was proved at operation to be dilatation of the cervical oesophagus which was caused by strangulation of the lower cervical part of the gullet by a scar from the previous operation on the neck. In this case, plication of the oesophagus was done with subsequent relief of symptoms.

Fig. 65. Temperature chart, showing the postoperative course.



T=Temperature
R=Pulse
R=Respiration

Chapter IX. Tumors of the Oesophagus.

Small benign tumours are occasionally found at autopsy. With the development of

Fig. 66. Postoperative röntgenogram.

Fig. 67. Postoperative portrait of the patient, B. F., male, aged 43 years.

Fig. 68. A case of myoma of the thoracic oesophagus.
The patient, K. Y., female, aged 43 years.
Preoperative röntgenogram.

endoscopic technique, polypi and papillomata are at times discovered. We have also located a polyp by oesophagoscopy.

In a patient who has been complaning of difficulty of deglutition for 24 years, and was diagnosed by us as a case of idiopathic oesophageal dilatation, we have enucleated a myoma from the oesophageal wall. After the myomectomy and oesophago-cardioplasty the patient has completely recovered her health and is at present engaged in her daily work. (Fig. 68—72.)

A graphic demonstration of the technique of this myomectomy and oesophago-

Fig. 69. A view of operative field (myoma is being removed).

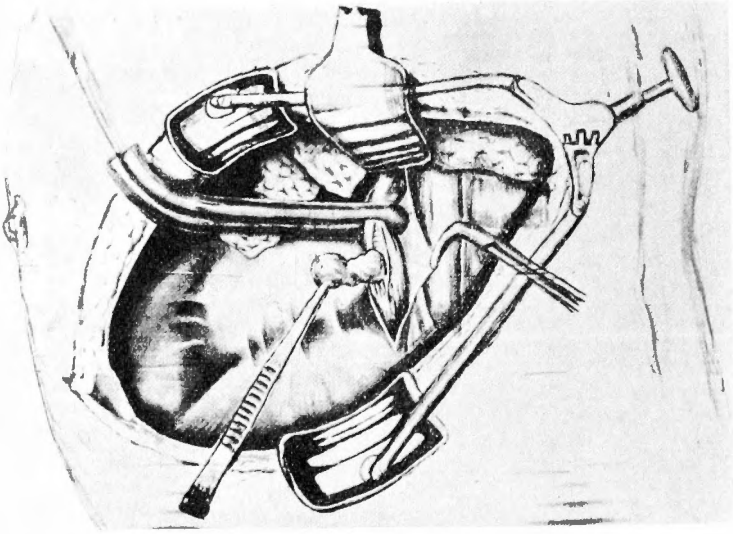
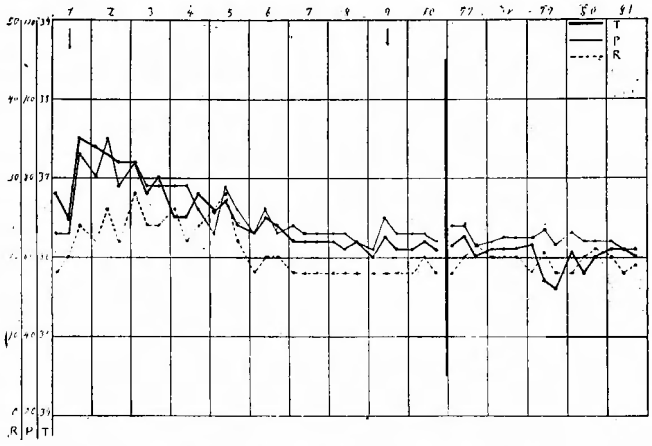


Fig. 70. Temperature chart of the same case as Fig. 68, showing the postoperative convalescence.



T...Temperature, P...Pulse, R... espiration

cardioplasty under free transdiaphragmatic thoracotomy was presented by cinematograph at Japan Surgical Society on April 1932.

Chapter X. Carcinoma of the Oesophagus, of the Cardia and of Upper Segment of the Stomach.

With the development of the operative technic the number of cases recognized as carcinoma of the oesophagus, the cardia, and the upper part of the stomach has

Fig. 71. Postoperative röntgenogram.

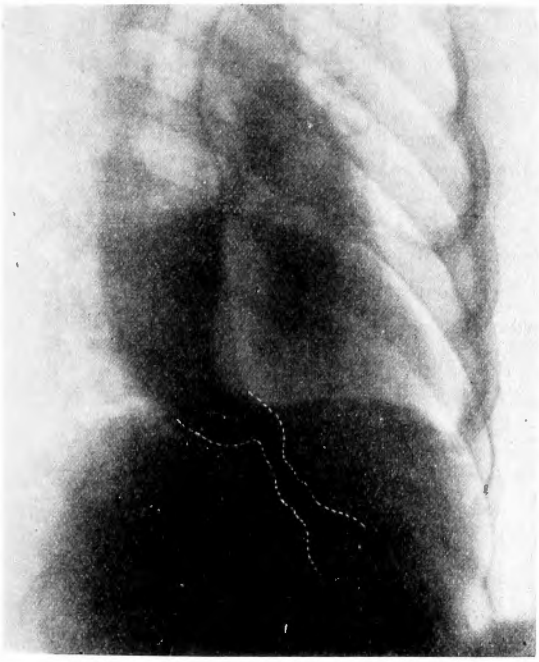


Fig. 72. Postoperative photograph of the patient.

Fig. 72. a

Photomicrograph of the specimen, the same case as Fig. 72.

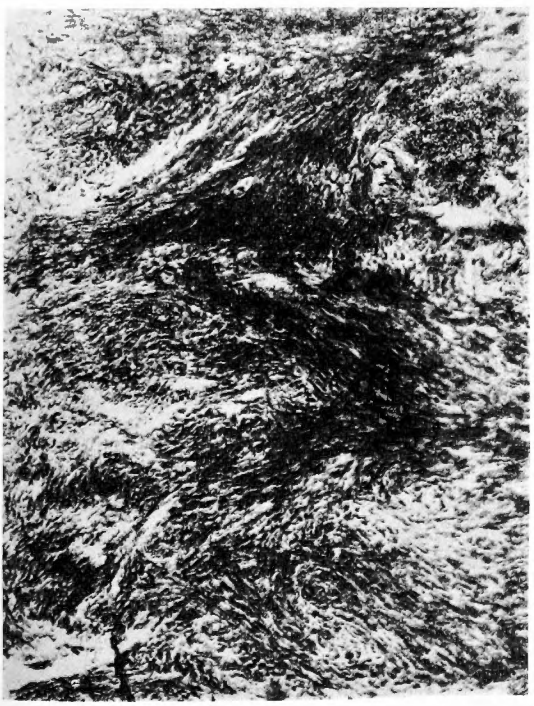


Fig. 72. b

Gross specimen of the same case as Fig. 72

gradually increased until it is estimated to be from 1/4 to 1/7 in frequency of that of the stomach. In our clinic, the total number of gastric carcinoma operated upon in the past 7 years is 803 as compared to 101 cases of carcinoma of the oesophagus and the cardia.

Classification of operations for carcinoma of the oesophagus performed during the eight year period, 1925-1932.

Penetration method and Gastrostomy.	Posterior mediastinotomy, section of the oesophagus and fixation of the tumor-bearing upper segment to the neck.	2
	Resection of the tumor-bearing segment of the oesophagus in the thoracic cavity and fixation of the upper stump of the gullet to the neck.	1
2 stage penetration method.		1
Section of the cervical part of the oesophagus and fixation of the upper stump in the neck.		2
Fixation of the tumor-bearing part to the thoracic wall.		1
Extrapleural posterior mediastinotomy, exploratory.		3
Exploratory anterior mediastinotomy.		1
Free transdiaphragmatic thoracotomy.		1
Free thoracotomy followed by gastrostomy or jejunostomy.		15
Free thoracotomy alone.		5
Tracheotomy and gastrostomy.		1
Gastrostomy or jejunostomy alone.		17
	Total	50

Classification of operations for carcinoma of the cardia performed between the years 1925 and 1932.

End-to-side oesophagogastrostomy (to the anterior wall of the stomach) after resection of the cardia.	5
End-to-end anastomosis between the oesophagus and the greater curvature of the stomach after resection of the cardia.	12
Einstülpungsresektion. (Sauerbruch)	1
Exploratory laparothoracotomy.	2
Laparothoracotomy and gastrostomy.	3
Laparothoracotomy and oesophagogastrostomy.	1
Exploratory laparothoracotomy and jejunostomy.	4
Exploratory laparotomy combined with gastrostomy or jejunostomy.	14
Exploratory laparotomy.	6
Transdiaphragmatic thoracotomy.	1
Incision of intraomental abscess due to perforation into the great omentum.	1

Isolation of the oesophagus (thoracotomy); fixation of the isolated part of oesophagus below hiatus; jejunostomy.	1
Total	51
Total gastrectomy with end-to-side oesophago-jejunostomy and jejuno-jejunostomy.	20

Since our clinic was established in 1903, the number of cases of carcinoma of the oesophagus and the cardia operated upon totalled 281, of which the great majority were males. The highest incidence occurred in the fifth decade, and the anatomical locations were mostly in the lower part of the oesophagus and the cardia, agreeing with the figures given in the foreign statistics, which fact, as mentioned in the introduction, demands urgently the solution of therapeutic problems of this region.

The results of the surgical treatment of carcinoma of this anatomical region are quite appalling. The total number of cases operated upon throughout the world is 150, of which in 53 cases the carcinoma was located above the tracheal bifurcation, in the remainder the lower part of the oesophagus and the cardia being the sites involved. Of these, 36 operations were done transperitoneally. The number surving the thoracic operation was only 5 cases, and in none of these was established any direct continuity between the oesophagus and the abdominal digestive tract. Of these cases receiving abdominal operations for carcinoma of the cardia, 14 cases survived throughout the world. A case reported by Miyagi is one of these, and has been the only successful case reported in our country to date. A further scrutiny of the literature reveals the fact that no one author has more than a single successful case to his credit. There is no wonder that the carcinoma of the cardia, to say nothing of that of the entire oesophagus, has been generally regarded as a hopeless therapeutic problem.

In our series of carcinoma occuring in the upper thoracic part of the oesophagus, there were 50 cases, of which 5 were operated upon. Of 51 cases of carcinoma of the lower part of the oesophagus and the cardia, 18 cases were operated upon. Of 803 cases of carcinoma of the stomach, 20 cases showing infiltration in the upper segments of the viscus were operated upon. The total number of cases operated upon was thus, 42, of which 20 cases were cured. Of 11 cases in which thoracic operation was performed 3 were cured, in two of which the total gastrectomy was followed by oesophago-jejunastomy under free laparo-thoracotomy. Of 14 cases in which resection was done for carcinoma of the lower part of the oesophagus and the cardia by our semithoracotomic laparotomy, successful result was obtained in 8. It was possible to resect the lowest 5 cm. of the oesophagus by this technic. With this technic and with pure laparotomy, 18 total gastrectomies were performed, and of these 10 cases were cured. (Table 44.) Thus, although our series is still a small one, it is our confident belief that with an increase in the quantity of material, the number of

Fig. 73. An illustrative case of carcinoma of the lower part of the oesophagus and cardia, on which a radical operation was performed.

The patient, R. T., female, aged 42 years.
Preoperative röntgenogenogram.

Fig. 74.

The same case as Fig. 73.
Postoperative chart.

T...Temperature
P. .Pulse
R...Respiration

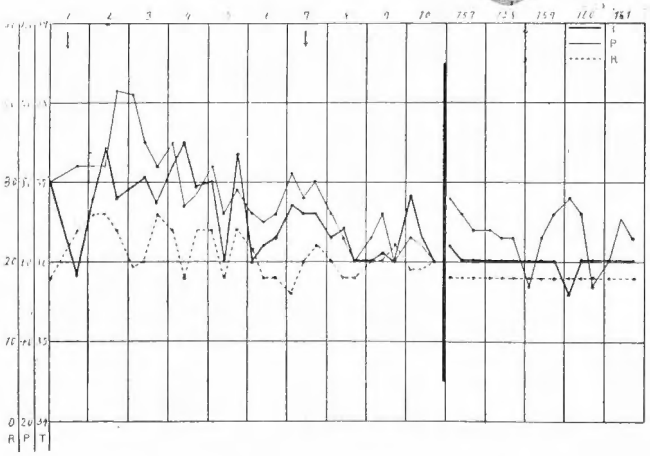


Fig. 75. The same case as above.
Postoperative röntgenogram.

Fig. 76.

The same case as above.
Postoperative portrait of the patient and specimen.

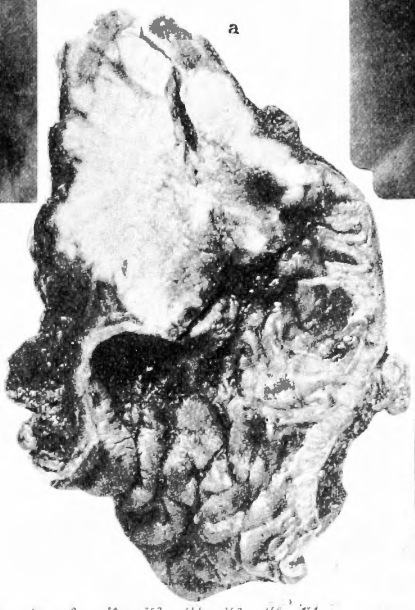
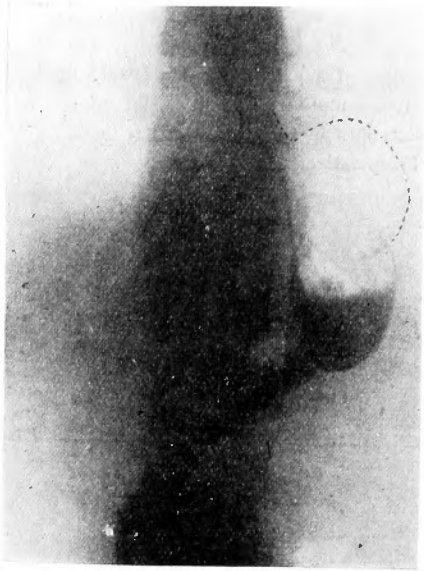


Fig. 77. An illustrative case of carcinoma of the lower part of the oesophagus; the patient., S. H., male, aged 45 years. Preoperative röntgenogram.

Fig. 79. Postoperative röntgenogram.



b

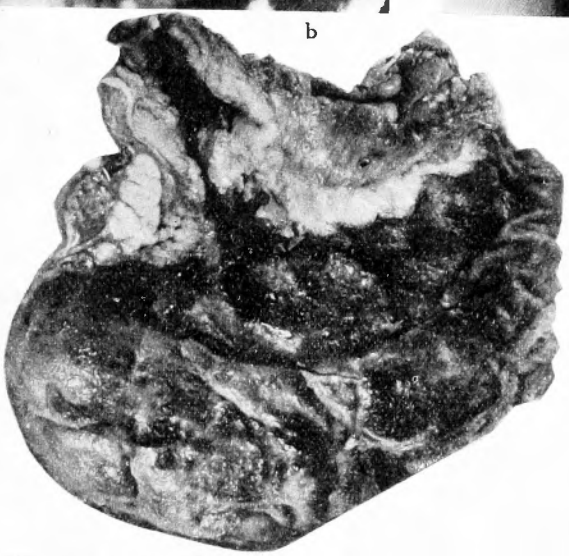


Fig. 78. Temperature chart, showing the postoperative convalescence. (The same case as Fig. 77.).

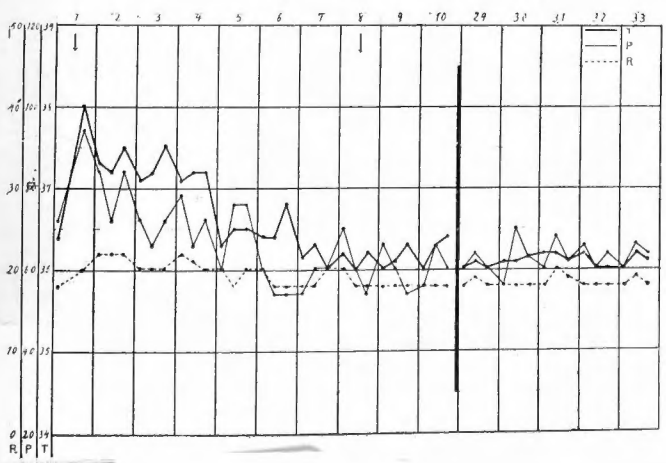


Fig. 80.

The patient after the operation and the specimen removed at operation. (The same case as Fig. 77.).

a

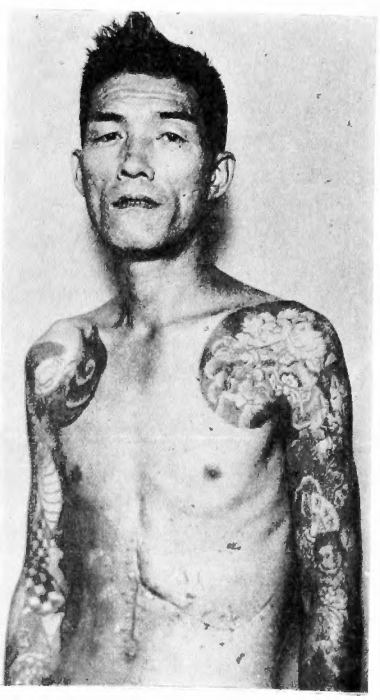


Fig. 81. The case of a patient, H. M., female, aged 47 years, representative of 12 successful total gastrectomies in the present series. Preoperative röntgenogram.

Fig. 82. Specimen of the stomach removed from the case shown in Fig. 81.

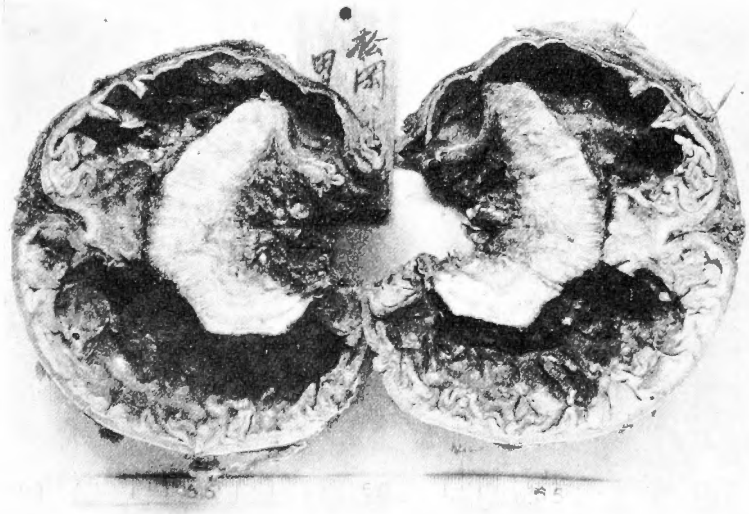


Fig. 83. The same case as Fig. 81. Postoperative temperature chart.

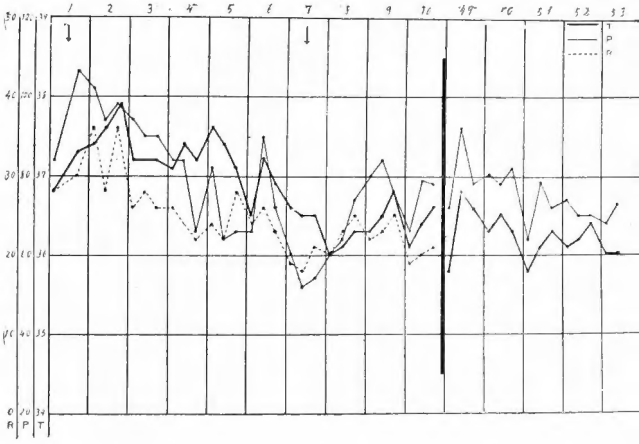


Fig. 84. Portrait of the patient (The same case as Fig. 81.).

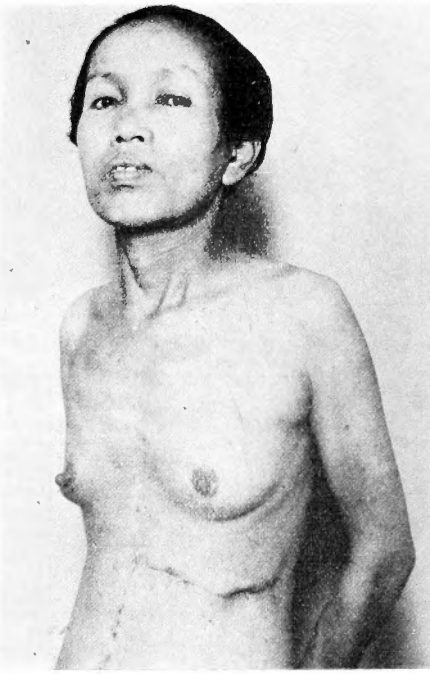


Fig. 85. Illustrative case of total gastrectomy.
The patient, T. Y., male, aged 57 years.
Postoperative röntgenogram.

Fig. 87. Temperature chart, showing the postoperative convalescence.
(The same case as Fig. 85)

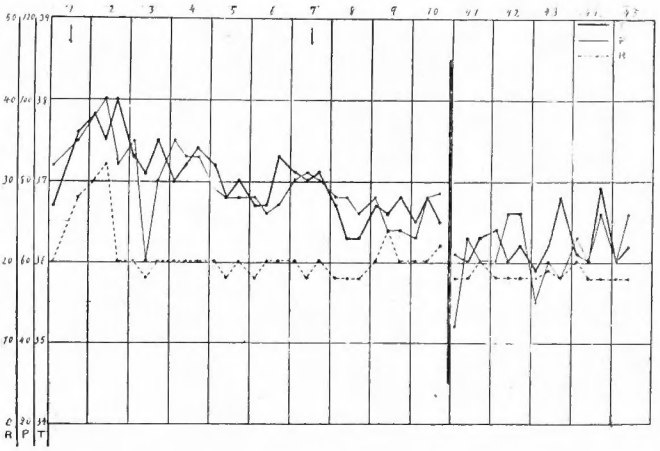


Fig. 88. Portrait of the patient.
(The same case as Fig. 85).

Fig. 86. The same case as Fig. 85. Specimen of the stomach.

successful cases will also increase. Detailed protocols of our clinical cases appear in my original paper in Japanese.

Table 44. Summary of cases of carcinoma of the oesophagus in which resection was performed.

Method of Operation	Site of Carcinoma	Number of cases	Result
Penetration method	Level of tracheal bifurcation	3	Died
2 stage resection (Penetration method)	Level of the tracheal bifurcation	1	Died
Anchorage to the thoracic wall	Between the level of the tracheal bifurcation and the cardia	1	Cured
Free thoracolaparotomy	Cardiac part of the oesophagus	2	Died
,,	Upper part of stomach and cardia	2	Cured
Free thoraco-trausdiaphragmatic-laparotomy	Cardiac part of the oesophagus	1	Died
Semithoracotomic abdominal method	,,	14	8 cases cured 6 cases died
,, and ordinary laparotomy	Upper part of stomach and cardia	18	10 cases cured 8 cases died
Total.....	.....	42	20 cases cured 22 cases died

Chapter XI. The Foreign Bodies in the Oesophagus.

Foreign bodies that are carelessly swallowed may lodge themselves at the various physiologic constrictions of the oesophagus, as shown on the accompanying table.

Character of foreign bodies and the parts of the oesophagus they were lodged.

The first physiological constriction.....	48	
Midway between the first and second physiological constrictions.	2	False tooth. Fish hook.
The second physiological constriction.	13	
Midway between the second and third physiological constrictions.	3	False tooth. Lump of meat. Pickled turnip.
Third physiological constriction.	6	Dried sea weed. Safety pin. Probe. A piece of iron rod. False tooth. A polished stone the size and shape of a quarter coin.
Stomach.	4	
Intestine.	4	
Location not mentioned.	17	
Total	97	

Fortunately these are quite frequently dislodged spontaneously and are passed downward in the alimentary tract. Thus, in our series of 97 cases, spontaneous passage and excretion occured in 23 cases, 6 of them being rather sharp edged artificial teeth. In these fortunate cases, the foreign bodies evidently had not penetrated into the mucosa. A piece of dried, thick seaweed (konbu) excreted in 26 days represents the longest record, and a round piece of tin, which was passed out within 17 hours the shortest record of foreign bodies lodged in the oesophagus in our series. Prognosis of the cases of foreign bodies in the oesophagus varies in proportion to the severity of disturbance of deglutition, 9 out of 14 fatal cases having come to us with a high grade disturbance.

Methods by which the foreign bodies were removed.

Non-surgical	By oesophagoscopy	20	36
	By means of coin forceps	13	
	By means of forceps	3	
Surgical			24
Spontaneous discharge through the anus (including 3 cases in which the foreign bodies were pushed down.)			23
Accidentally removed			3
Extraction could not be accomplished			2
Not recorded			9
	Total		97

While it is true that the recent refinement of oesophagoscopic technique has reduced the number of operative attempts at removal of foreign bodies, yet in those cases in which they have insinuated themselves into the mucosa or in which signs of complication exist, an immediate surgical intervention should be made.

In the removal of foreign bodies, an external cervical oesophagotomy possesses the widest range of applicability. Through the oesophagotomy wound, an endoscope may be introduced, and extraction may be completed of foreign bodies located not farther down than 2 cm. below the tracheal bifurcation. With this method, an additional gastrotomy may often be omitted. Farther down in the oesophagus, an extraction is sometimes impossible even through a gastrotomy wound. Yet, to take a recourse to thoracotomy in such cases, is fraught with danger, and since our past experiences amply prove it, an intrathoracic operation should be avoided as far as possible.

It is for such seemingly impossible cases, that we have devised a combined method of gastrotomy and free thoracotomy. By this method it is possible to grasp the foreign body with one hand, palpate the base of the object with a finger of the other hand introduced into the oesophagus through the gastrotomy wound, and push it bimanually downward.

Fig. 89. The case of foreign body successfully removed by our combined thoraco-abdominal method.
Preoperative röntgenogram.

Fig. 91. Temperature chart showing the postoperative course of the case shown in Fig. 89.

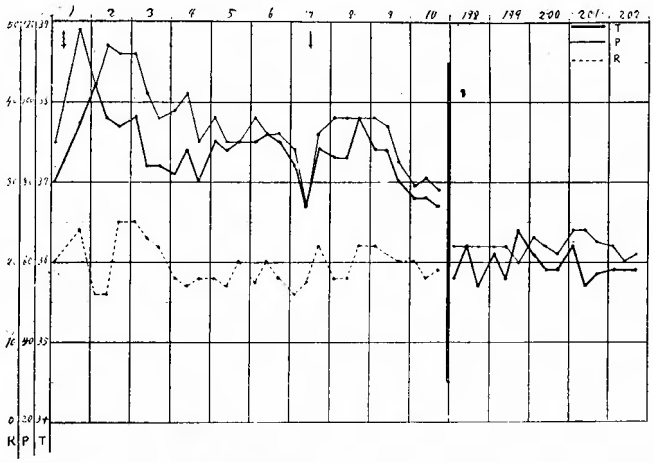
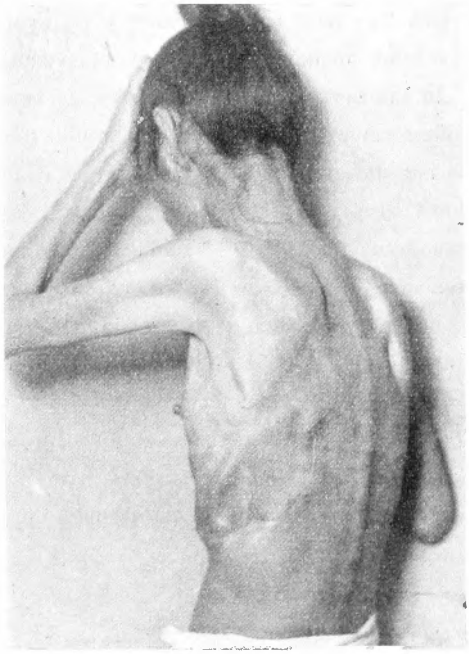


Fig. 90.
The foreign body removed. The same case as Fig, 89.

Fig 92.
Portrait of the patient (Fig. 89), T. E., female, aged 55 years.

a

Fig. 92 b



Our case was that of a woman 56 years of age with impaction of an artificial tooth at the second constriction for which several expert otorhinologists had attempted an oesophagoscopic extraction. The patient came to us on the 9th day of the accident. We first tried a retrograde oesophagoscopy but found that the foreign body moved not at all, and that there was considerable inflammation in the adjacent mucosa. We have finally succeeded in extraction by our combined method, and both wounds healed promptly without an infection.

The bimanual method is the ideal one for extracting a foreign body impacted in the mucosa of the deeper part of the oesophagus. Of a combined method, a mention is made in the literature, but to our knowledge there is no actual successful employment of the method reported (Fig. 89—92.)

Chapter XII. The Disturbed Deglutition by Pressure.

Although the conditions vary in different regions, the oesophagus is occasionally displaced or compressed by a pressure exerted by adjacent structures. Since the cervical part is limited in mobility, it develops a compression symptom rather early. The thoracic part, on the other hand, is at first displaced owing to its rather free mobility, and the symptoms of compression develop only when the oesophagus itself becomes involved in the pathologic process. Causes of compression are multiple, as the accompanying table shows.

The List of Diseases Which may Cause Disturbances of Deglutition by Pressure.

1. Diseases of the thyroid glands.
2. Ossification of the cricoid cartilage and inflammation and tumor of the neck.
3. Diseases of the mediastinum.
4. Diseases of the heart and the aorta.
   a. Abnormal anatomical course of the right subclavian artery.
   b. Intrinsic diseases of the arteries.
   c. Diseases of the heart itself.
5. Diseases of the lungs.
6. Diseases of the diaphragm.
7. Diseases of the abdominal viscera.
8. Diseases of the vertebrae.

We have studied a case due to changes in the vertebral column, 4 cases due to pressure from malignant goiter, and 15 cases due to mediastinal tumors, in all of which the chief complaint was difficulty of deglutition. Although rare, there was also a case which was laparotomized with a diagnosis of tumor of the cardia, but which was actually a case of compression stenosis due to splenomegaly secondary to cirrhosis of the liver.

Concluding Words.

As stated above, the results of both our experimental studies on animals and clinical operations on man have contributed facts modifying the current conception of thoracotomy, and it is believed that the various experimental investigation on the oesophagus as well as the results of the therapeutic measures herein presented, have yielded informations that constitute the foundations upon which the surgery of the oesophagus may be built up.

In the course of 7 years since 1925, we have operated on 143 cases out of the total of 213 cases of the diseases of the oesophagus which we have studied. The majority of these cases were carcinoma. Of these 143 cases, those in which the thoracic part of the oesophagus was attacked by free thoracotomy numbered 68. From this experience we have assured ourselves that the practicable method of approach is the posterior transpleural-mediastinal route and the lateral transpleural route or unilateral thoracotomy, both under the normal atmospheric pressure.

For an operation on the lower part of the oesophagus and the cardia, either free transdiaphragmatic thoracolaparotomy, free thoraco-laparatomy, or semi-thoracotomic-laparotomy is believed to be the ideal method of approach. And in dealing with this region, the abdomen should be opened first.

With the exception of the cervical part, the oesophageal surgery is necessarily concerned with the thoracic cavity. With full understanding of the principles and practice of free thoracotomy, it is possible to perform an operation without fear and at any time. Our so-called semithoracotomic-laparotomy is primarily and almost purely a laparotomy, but with this difference, namely that there is no fear entertained for injury to the pleura.

Of our 143 operative cases, the operative procedure primarily planned was carried out on 63, of which successful cases are extremely few. But successful results in 4 out of 12 cases of tumors of the thoracic part of the oesophagus, cures in all the six cases of idiopathic dilatation treated by our method of intrathoracic oesophagoplasty with complete mobilization of the cardia at the oesophageal hiatus, success in 8 cases of the radical extirpation of carcinoma of the cardia by resection of the lower 5 cm. of the oesophagus by our semi-thoracotomic laparotomy which is employed in the identical sense as laparothoracotomy, cure obtained in 12 cases of total gastrectomy by a semithoracotomic laparotomy or by an ordinary laparotomy, and a successful bimanual extraction of a false tooth, hitherto considered as the most difficult foreign body, lodged in the mucosa by the combined method of free thoracotomy and gastrotomy, are results not yet superseded by European or American records. The credit for this record is due to none other than free thoracotomy.

It is also not without interest that we have obtained an ideal result in a case of cicatricial stricture with antethoracic oesophagoplasty by utilizing a skin-jejunal canal, and by the to-and-fro bougie dilation in a case of a child 4 years old.

〔内容抄錄〕 食道殊ニ胸部食道ニ對スル觀血的手術ハ ㄴ過壓裝置ガ全然無用デアルバカリカ却ツテ妨ゲトナルコト┐ノ事實ガ漸ク知レ渡ツテ來タ今日ニ於テ辛ウジテ正シキ研究ノ道程ニ進ミ入ツタカノ觀ガアル。

此ノ外科的領域ニ向ツテ 1925 年鳥潟教授ガ始メテ平壓開胸術ヲ主張サレテ以來，吾々ハ實驗的，臨床的ノ研究ヲ續ケテ今日ニ至ツタ。而シテ食道外科全般ノ研究ヲ一擧ニシテ解決スルハ到底至難ノ事デアル。吾々ハ先ヅ食道外科ニ於ケル根本問題ヲ闡明シ，食道外科ノ第一歩トシテ食道下部噴門部ノ外科ヲ確立セントシタ。

甲 診斷的事項

食道疾患ノ早期診斷ハ食道外科ノ進歩ニ重大ナル關係ガアル，吾々ノ手術例胸部食道癌 50 例，食道下部噴門癌 51 例中ニ於テ切除出來タモノハ前者 5 例，後者 18 例デアツタ。而モ此切除例ノ半數以上ハ嚴密ナ意味カラノ適應症デハナカツタコトニ鑑ミテモ早期診斷ヲ刻下ノ急務ト考ヘル。

食道疾患ノ診斷ハ必ズ X 線診斷法ト食道鏡診斷法ノ系統的診斷ニ俟ツ可キモノデアル，X 線診斷ニ於ケル骨盤高位診斷法ハ腫瘍，又ハ狹窄其他ノ下界所見ヲ明カニ爲シ得ル，本法ハ殊ニ噴門癌ニ於テ重要デアル(藤浪)。

X 線診斷法ニ於テハ疑ハシキ初期患者ニ對シテ必ズ藥理學的診斷法ヲ行ヒ機能的及ビ器質的疾患ノ鑑別ヲ爲サナケレバナラナイ(藤浪)。

食道運動曲線診斷法ハ，獨立ノ診斷法トハナラヌガ診斷ノ參考トナシ得ル，卽チ食道壁癒着ノ有無ハ此曲線カラ知リ得ル(鬼束)。

乙 實驗的事項

偏側平壓開胸術ト肺臟機能トノ關係ニ就テハ，手術中健側肺臟ノ代償ニヨツテ充分ナル機能ヲ遂グルコトハ，今回ノ實驗ニ於テモコレヲ證明シタガ，更ニ一歩ヲ進メテ手術後ノ肺臟機能ヲ檢査スルニ，術側肺臟機能ハ左側平壓開胸術ニ於テハ間モナク(術後 3 時間)術前機能ニ恢復スルガ，過壓開胸術ニ於テハ術後時間ノ經過ト共ニ漸次機能低下シ，3 週間ヲ經過スレバ愈々低下シ，動物ハ遂ニ衰弱スルニ至ルコトヲ明カニシタ(勝呂・春野)。シカモ開胸中及ビ開胸後ノ心臟機能障碍ハ，過壓開胸術ニ於テ甚シク(石原)，術後短時間內ノ肝臟機能障碍モ亦過壓開胸術ニ僅カナガラ之ヲ認メ(岡)，赤血球沈降速度(淺野)，肋膜吸收 (落田)，及ビ感染(淺井)ノ實驗的檢査ニ於テモ，術後平壓開胸術ニ比シテ，過壓

開胸術ノ影響ガ著シク強イコトヲ認メタ。閉鎖時ノミ過壓ヲ裝用スルモノヽ成績ハ，何レノ實驗ニ於テモ兩者ノ中間ヲ行ク様ナ結果デアル。斯クノ如ク各人ニヨリテ相互無關係ニ遂行セラレタル實驗ノ成績ガ期セズシテ一致セルコトハ，決シテ偶然デハナイト信ゼラレル。

人體平壓開胸術ニ於ケル術前後ノ呼吸(小津)，血壓(岩城)，基礎代謝(福間)，血像(長岡)，血糖(仲田)等諸種ノ檢査成績モ亦，一般侵襲ヨリ以上ノ影響ヲ受ケルモノデナイトイフ結果トナツタ。

又吾々ハ人體平壓開胸術約 90 例ノ觀察ニ於テ(宮司・林)，手術中呼吸及ビ血壓ハ何レノ部分ニ於テ何レノ側ヨリ開胸シタ場合ニ於テモ，開胸口，開胸時間，麻醉等ニハ毫モ影響サレルコトナク，各個人胸廓ノ構造ト，呼吸トノ間ニモ一定ノ關係ヲ見出サナイ(藤浪・小津)。所謂，縱隔竇動搖說ハ人體ニアリテハ，全ク根據ナキ假說ニ過ギナイコトヲ確認スルニ至ツタ。

肋膜ノ吸收能力ハ無菌的開胸術ニ於テハ決シテ障碍ヲ受ケヌノミカ，却テ增强スルヲ知リ(落田)，肋膜ノ感染ハ氣胸ノ存在ニヨツテ最モ强ク左右セラルヽガ，其感染ノ豫防處置トシテ外科的ニ講ズル諸操作ハ効果ヲ示シ難ク(淺井)，肋膜ノ缺損ハ縱隔肋膜デモ，横隔肋膜デモ筋膜又ハ皮下組織ノ移殖ニテ補塡成形ノ實ヲ擧ゲル(五郎川)。肋膜感染ノ豫防及ビ治療トシテ，コレヲ免疫的ニ處置スルコトノ有効ナルコトハ從來主張シ實行シテ居ル所デアルガ，免疫ノ力ハ煮沸免疫元ガ，生免疫元或ハ肉汁ニ比シ 2 倍乃至 2.5 倍强大デアリ，時間的ニハ 24 時間後强大ナルコトヲ立證シタ(青柳・富田)。

横隔膜ハ横隔膜神經ノ麻醉，挫滅，切斷等ニヨツテ一時的，又ハ一定期間運動ヲ停止セシメ，手術操作及ビ術後手術部治癒ニ有利ナラシメルコトガ出來(仲田)，横隔膜食道裂口ヲ擧上シ，胸部食道下部ノ大半ヲ腹腔內タラシメルコトモ出來(春野)，(人間ニテハ約 10 糎)，又人工的假性横隔膜ヘルニアハ，腹腔臟器ノ嵌頓ヲ起サヌ限リ生命ニ危險ヲ及ボスモノデハナク，1 側肺臟壓縮サレ機能ヲ失フトモ他側肺臟之ヲ代償シ生存シ得ル。本研究ハ胸腹兩腔ヲ手術時ノミナラズ手術後ニモ連通シ，胸腔ヲ腹腔化シ得ルコトヲ立證シタモノデ，食道外科ニ於ケル重要ナル事項ト信ズル(荒木・盛・藤浪)。

食道手術ノ根本トナル食道ノ解剖生理ニ關シテ，吾々ハ第1ニ食道及ビ胃ノ循環系統ヲ精細ニ檢索シ，未ダ試ミラレヌ其ノ定量的研究ニヨリ，全食道(都谷)，全胃(仲田)ノ榮養關係ヲ確定シ，食道ノ抵抗薄弱部ヲ知リ，又食道ノ淋巴系，胸管ノ關係ヲ明カニスルト同時ニ，其ノ障碍ノ際ニ於ケル淋巴流ノ變化，及ビ副枝淋巴行ノ新生事實ヲ知リ(貴志)，食道壁ノ組織的檢查ハ食道ノ切除縫合ノ好參考資料トナリ(赤木・貴志)，食道生理ノ研究ハ從來不明デアツタ食道交感神經支配ガ，迷走神經支配ニ對シ調節的乃至拮抗的ニ作用ス

ルノ事實ヲ立證スルニ至ツタ(東)。

迷走神經ノ各部位ニ對スル切斷，挫滅，索引其ノ他諸種刺戟ガ，直接心臟機能及ビ肺臟機能ニ與フル影響ヲ觀察スルニ，上位神經根幹ヲ破壞スルガ如キ刺戟程，呼吸機能ニ强キ影響ヲ與ヘルガ，血壓ハ下位刺戟ニ對シテモ相當ニ影響セラレルコトアルモ 24 時間後ニハ概ネ恢復スルコトヲ知ツタ。之等ノ影響モ該神經ノ麻醉後ニ行ハレル時ハ影響ガ少イ(東)。心臟ノ長期壓迫ハ心臟機能障碍ヲ招來スルハ當然デアルガ，殊ニ心房ノ壓迫ハ最モ不良ノ影響ヲ與ヘルモノデアル(石原)。之等ノ諸事實ハ何レモ食道ノ手術ニ當リ注意ヲ要スル事項デアル。

食道ノ切開或ハ斷端ノ縫合方法ニハ，最近吾ガ敎室ニ於テ胃切斷端其ノ他胃腸縫合ニ行ハレルト同樣ノ各層縫合ガ特ニ優秀ナル成績ヲ示シ(荒木・岡・山根)，切開口ノ縫合ニハ橫縫合ヲ施セバ狹窄ヲ避ケルコトガ出來(山根)，端々吻合ノ可能範圍ハ 4 糎ヲ超エザルコトヲ明カニシタ(岡)。食道ノ切斷及ビ斷端閉鎖法ニハ，最近吾々ハ新シイ方法ヲ採用シ出シタ。

從來行ハレタル諸種切除法ノ比較研究ニヨレバ，何レモ結果不良デアルガ，術式的ニ大綱膜包被法ヲ行フコトハ，吻合癒合補助トシテ極メテ優良確實デアル(荒木)。

從來ノ方法中癒合ノミヲ旨トスル Witzel 胃瘻式，Sauerbruch 胃內套陷法ノ如キ癒合必ズシモ確實デナク，術後ニ惹起セラル、完全ナル狹窄ハ到底實地上應用ノ價値ナク，併モ Sauerbruch 胃內套陷法ニ至ツテハ手術目的ニ肝腎ナル切除ニ於テ不確實極マルモノデアリ，特徵ノ 1 ツデアル「操作ノ淸潔」ニ於テモ，最モ疑ハシキモノデアルコトヲ動物及ビ人體實驗上明カニシタ(荒木)。

食道斷端ヲ閉鎖放置スルコトハ窮余ノ一策デアルガ，其ノ可否ニ就テ實驗上癒合ノ可能性ハ認メラレルケレドモ，生存率少ク原則的ニ採用スベキ方法デハナイコトヲ知ツタ(荒木)。

食道造設術ニ關スル實驗ニ於テハ手術ノ安全性ト術後生理的關係等カラ，皮膚空腸管ヲ頸部食道ト胃トノ間ニ連絡スル方法優レテ居ルコトヲ認メルガ，遊離空腸管ニ招來シ易イ循環障碍ニ對シテハ，大綱膜包被法ヲ行フ事ガ最モ有効ナル處置デアル(石原)。一定限度ノ食道缺損部ノ補塡ハ無莖筋膜ノ移殖デ目的ヲ達スル(赤木)。

叙上ノ人體及ビ動物ニ於ケル諸種實驗結果ハ開胸術ニ對スル從來ノ考ヘニ大ナル訂正ヲ加ヘタ外，今後ノ食道外科ニ幾多ノ基礎的知見ヲ與ヘ得タモノト信ズル。

諸種食道手術ヲ 1925 年以後 7 年間ニ，213 例ノ診斷例中手術 143 例（非觀血的手術ヲ含マズ）ヲ自ラ經驗シタガ其ノ多クハ癌腫ニ行ハレタ，卽チ癌腫 120 例中デ，43 例ニ根治手術ヲ施行スルコトガ出來タ。文獻デハ前世紀以來全部デ約 150 例根治手術ガ報告サ

レテ居ルガ，食道癌ノ5例，噴門癌ノ10余例ガ，術後治癒ヲ得タノミデアル。而モ胸腔内デ腹部消化器トノ間ニ吻合ノ行ハレテ生存シタモノハ1例モナイ，吾々ハ斯カル2例ヲ生存セシメタノデアル。

此ノ他吾々ノ手術例トシテハ食道筋腫剔出術，食道遊離成形術，食道胃吻合術，胃内套陷法，異物摘出術，食道造設術，頸部食道造瘻術，無端消息子法等デアル。

吾々ノ根治手術例ハ尚甚ダ寥々タルモノデアルガ，胸部食道ヘノ進入56例ヲ施行シ種々ナル經驗ヲ得タ，即チ胸部食道進入切除術式トシテ實地ノ應用ニ適スル術式ハ平壓ノ下ニ施行スル後縱隔竇切開法，及ビ側胸切開法(偏側平壓開胸術)デアリ，食道下部噴門部ニハ從來吾々ノ主張シ實行シテ居ル平壓開胸洞横隔膜開腹術，或ハ平壓開胸開腹術若クハ吾々ノ行フ準開胸肋骨切除式腹腔術式ヲ最モ有利ナモノト信ズル。

而シテ各術式ハ腫瘍ノ部位ニ依テ定メルノデアルガ，氣管分岐部附近ノ腫瘍切除ニアツテハ吾々ノ案出シタ2次的切除法之ニ適シ食道下部噴門部ノ腫瘍ヲ切除セントスル場合ニハ，常ニ先ヅ開腹シテ胃ノ遊離ヲ用フ可キデアル。而シテ食道吻合術後ニハ空腸瘻設置ハ不必要ニシテ一般胃腸吻合術ノ場合ト同様ニ術後2—3日目カラ經口的ニ食餌ヲ與ヘテモヨイ。

吾々ハ是等ノ食道手術ニ於テ食道患者ハ一般ニ榮養ガ非常ニ惡ク，抵抗力モ亦豫想外ニ薄弱ナルコトヲ經驗シタ。營養增進其ノ他ノ目的ニ手術前後ノ輸血ハ大ニ有効デアツタト考ヘル，術後開胸施行後ノモノハ特ニ酸素吸入ヲ行フ外，氣胸及ビ胸腔潴溜液ノ存否ニ注意シ時ヲ失セズ吸引除去ニ努メル，肺炎及ビ一般感染ニ對シテハ免疫的處置ニヨリ豫防ヲ怠ラナイ。

食道ノ吻合部ハ人體材料ノ檢査ニヨレバ4週間デ癒合ヲ遂ゲルモノデアリ(赤木)，X線檢査ニヨレバ噴門部機能ヲ缺如スルガ通過障碍ハ吾々ノ縫合法ニヨルモノニハ一切之ヲ見ナイ(藤浪)。

迷走神經切斷後ノ胃ノ運動ハ人體食道噴門癌切除ノ6例ニ檢査シ，幽門不全及多少ノ通過遲延ヲ認メ，腸ノ運動ニハ通過時間，蠕動狀態ニ變化ヲ認メズ(山根，藤浪)，全胃剔出後及食道噴門癌切除後ノ基礎代謝ハ術直後低下スルモ6週後恢復シ且ツ爾後向上スル(福間)。

食道ノ各疾患ニ關シテハ教室員(吉田，松本，庄山，森岡，橋本，西尾，宮司，高安，有野，奥村)ノ統計並ビニ教室ノ經驗例ニ就テ述ベル。

吾々ノ臨床手術例143例ノ中デ豫期ノ手術ヲ行フコトノ出來タ例ハ63例デアル，此ノ中胸腔内ニ於ケル腫瘍切除ノ11例中，4例ノ術後治癒ヲ擧ゲ得タルコト，ザ氏胃内套陷法1例ヲ全治セシメタコト(吾々ハ此方法ヲ切除ノ目的ニ使用シタノデハナイ)，又吾々ノ

胸腔內食道遊離成形術ガ 6 例共全部全治ノ成績ヲ擧ゲ得タルコト，開胸ト同意味ニ於テ採用サレル吾々ノ腹腔術式ニ於テハ，食道下部最高 5 糎迄ガ安全ニ切除サレテ治癒シ，7 例ノ全治者（其ノ他 1 例 3 週生存）ヲ擧ゲルコトガ出來タコト，此ノ術式ニ於テ 10 例ノ全胃別出治癒者ヲ出シタコト，其他異物ノ第 2 狹窄部ニ嵌入シタモノニ胸腹合併法ヲ施行シ，安全ニ取出シ得タ例ノ如キハ，何レモ食道外科ノ文獻ニ多少ノ寄與ヲ爲シタカト考ヘル，瘢痕狹窄ニ行ハレタ前胸食道造設術ハ僅カ－ 1 例デアルガ，我ガ國ニ於テハコレガ嚆矢デアラウ。

又同症ニ對スル無端消息子法モ我ガ國デハ僅少ノ例ガ報告サレタノミデ，特ニ 4 歲ノ幼兒ニ施サレ好結果ヲ得タノハ外國文獻ニモ多ク見出サヌ所デアル。然シ乍ラ尙ホ例症ハ甚ダ不足デアルガ今後間斷ナク努力ヲ續ケレバ漸次增加スルコト、考ヘ將來共ニ大方諸賢ノ御援助ヲ乞フ次第デアル。

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